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Vol. 73 JULY 1959 No. 1

The Significance of Alterations in the Lung Arterial Pattern[1]

WILLIAM H. SPRUNT, M.D., RICHARD M. PETERS, M.D., and DAVID L. HOLDER, B.S.

KNOWLEDGE OF the arterial blood supply to the lungs, which can be determined by standard radiographic methods, may be helpful in establishing their physiologic status. Classical pulmonary function tests, such as the determination of vital capacity, maximal breathing capacity, and timed vital capacity, only measure ventilation; they do not evaluate perfusion of the lungs. A localized deficiency in ventilation is measured only as a total deficit in function by these methods unless a complicated technic such as bronchospirometry is used. The information about the lung circulation which is obtained by the radiographic procedures to be described, interpreted on the basis of well accepted pathophysiologic data, will aid in the evaluation of pulmonary abnormalities and in the selection of patients for surgical treatment.

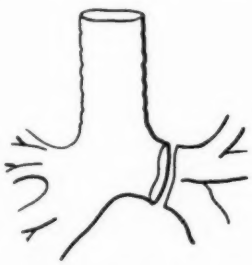

Fig. 1. Drawing showing the point at which transection of the bronchus was performed, sometimes on the left and sometimes on the right.

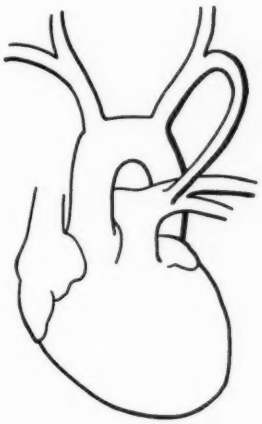

Fig. 2. Diagram of an anastomosis between the left subclavian artery and the main pulmonary artery (Blalock procedure).

MATERIAL

In order to demonstrate the clinical usefulness of such information, venous and aortic angiography was performed in dogs after the pattern of blood supply to the lungs had been altered in three ways:

(1) By transection and suture of a main bronchus (Fig. 1), which has been shown to diminish the pulmonary artery blood supply to the atelectatic lung without any in-

[1] From the Departments of Radiology and Surgery, The School of Medicine, University of North Carolina, Chapel Hill, N. C. Presented as part of a Symposium on Cardiovascular Roentgen Diagnosis at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958.

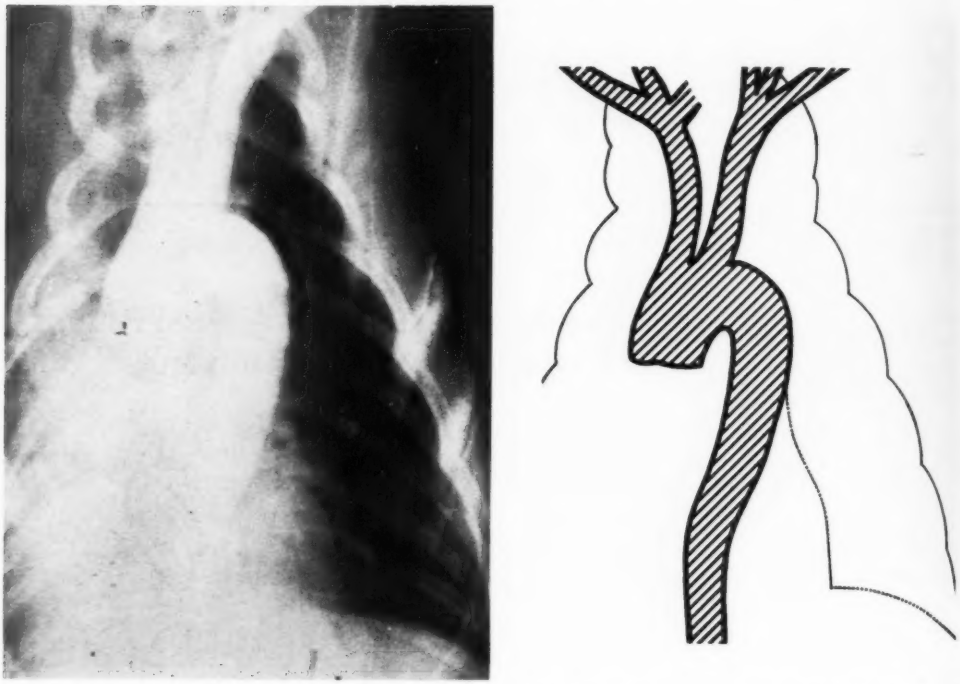

Fig. 3. Retrograde aortogram in a dog with transection of the right main bronchus, showing no evidence of bronchial collateral circulation on either side. The intercostal arteries are not filled.

crease in the bronchial collateral circulation(1). When studies were completed at this stage, some of the animals were operated on a second time and the transected bronchus was anastomosed; this was done twelve to twenty-four months after the initial transection.

(2) By ligation of a main pulmonary artery, which leads to the development of extensive bronchial arterial collateral circulation.

(3) By anastomosis of the left subclavian artery to the pulmonary artery (Blalock procedure) (Fig. 2). This simulates the pulmonary plethora seen with left-to-right shunts and provides an easily demonstrable systemic-pulmonary artery anastomosis.

After completion of the radiographic studies, autopsies were performed on some of the animals, followed by plastic and barium injection studies, in order to verify anatomically the impressions gained from the films.

RADIOLOGIC FINDINGS

In animals in which a bronchus had been transected, there was a prompt collapse of the lung, accompanied by a shift of the mediastinum toward that side. This was associated with increased expansion of the normal lung, which soon became distended enough to occupy almost all of the chest. Aortograms revealed no filling of the bronchial arteries on either side under these conditions of chronic atelectasis (Fig. 3). Venous angiography (Fig. 4, A) provided good visualization of the pulmonary arteries on the unoperated side of the chest. In addition, these vessels were two or three times larger than normal and were widely spread, as would be expected from the compensatory overexpansion of the normal lung. The pulmonary arteries on the operated side were much smaller, were outlined less distinctly, and were crowded together in the partially collapsed lung.

Satisfactory anastomosis of the transected bronchus, as demonstrated by bron-

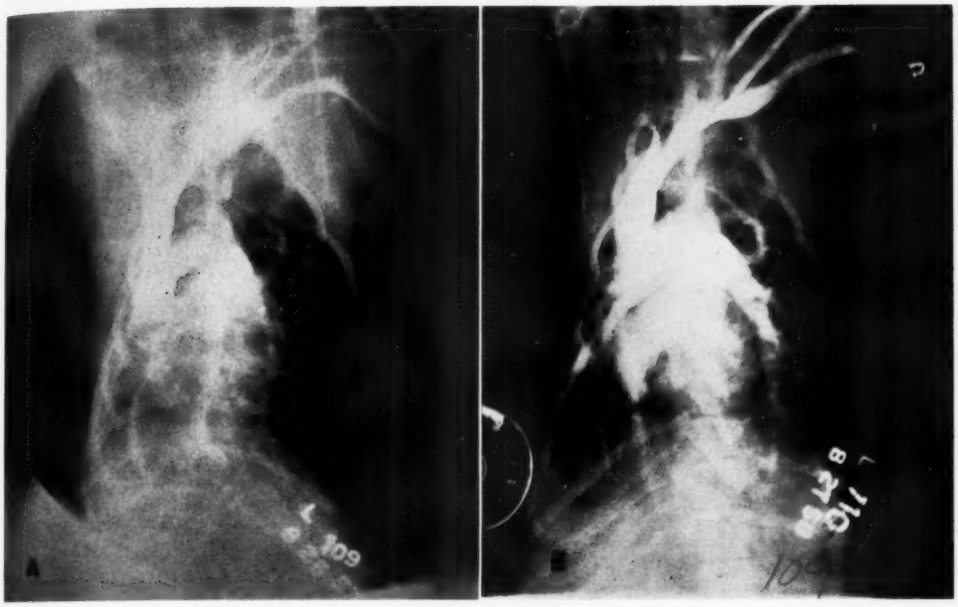

Fig. 4. A. Cardiac angiogram of a dog three months after transection of the right main bronchus and collapse of the right lung. The heart and mediastinum have shifted into the right chest. The contrast-filled pulmonary arteries are well visualized on the left, curving back across the midline as the overexpanded normal lung partially fills the right chest. The pulmonary arteries on the right are so small and poorly filled that they can hardly be identified.

B. Repeat venous angiogram three months after anastomosis of the right main bronchus on the same dog. There is now abundant evidence of filling of the right pulmonary arteries, although the vessels on the right still seem a little smaller than on the left.

chography, was associated with re-expansion of the previously collapsed lung and return of the pulmonary arteries of the operated side to an essentially normal size and position (Fig. 4, B).

When the main pulmonary artery was ligated, the lung remained expanded, occupying its normal volume. The mediastinum did not shift. The cardiac shadow seemed to cover a larger area than normal in the frontal projection, perhaps due to rotation of the heart. Venous angiography (Fig. 5) demonstrated the effectiveness of the ligation, for no contrast material entered the ligated vessel. There was a slight increase in the size of the vessels on the normal side. Retrograde aortograms (Fig. 6) showed good filling of the intercostal arteries bilaterally, a little more distinct on the side of the ligated vessel than on the normal side. In addition, on the side of the ligated pulmonary artery, the films showed a fine network of small vessels, about the size of the intercostals, most prominent in the region of the main bronchus, representing the branching bronchial arteries. This impression was confirmed at autopsy and by postmortem injection studies from the aorta, for many tortuous, dilated bronchial arteries could be seen, vessels which could be recognized only with difficulty in control animals.

Venous angiograms after a left subclavian-pulmonary artery anastomosis had been performed (Fig. 7) produced good contrast filling of the right pulmonary artery. The left pulmonary artery was less well visualized during the first few seconds after injection, probably due to the dilution of its contents by the stream of blood entering it from the systemic vessel, which of course contained no contrast material. Retrograde aortography (Fig. 8) demonstrated the systemic-pulmonary artery shunt and the left pulmonary artery well, confirming the impression obtained from venous

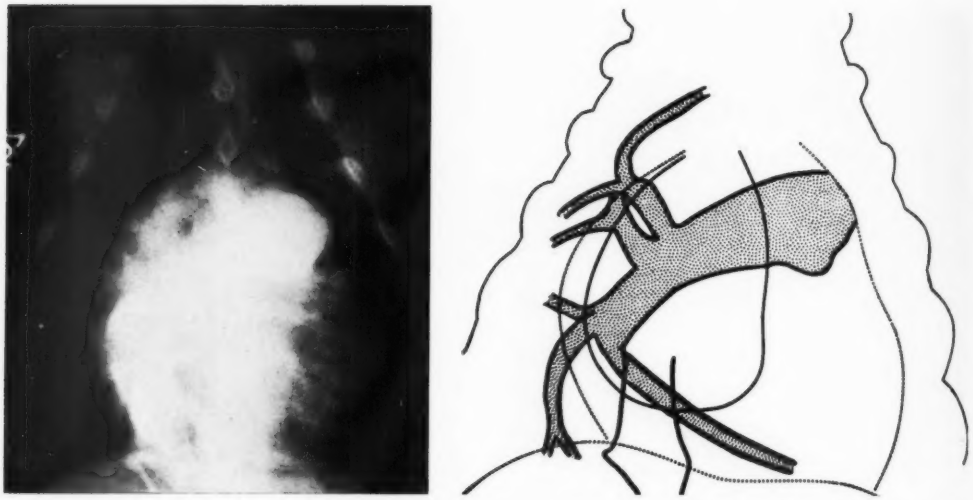

Fig. 5. Venous angiogram showing filling of the pulmonary arteries in an animal in which the left main pulmonary artery has been ligated. The pulmonary artery is well filled on the right and slightly dilated, but on the left only the stump of the pulmonary artery is seen. Note that there is no collapse of the left lung.

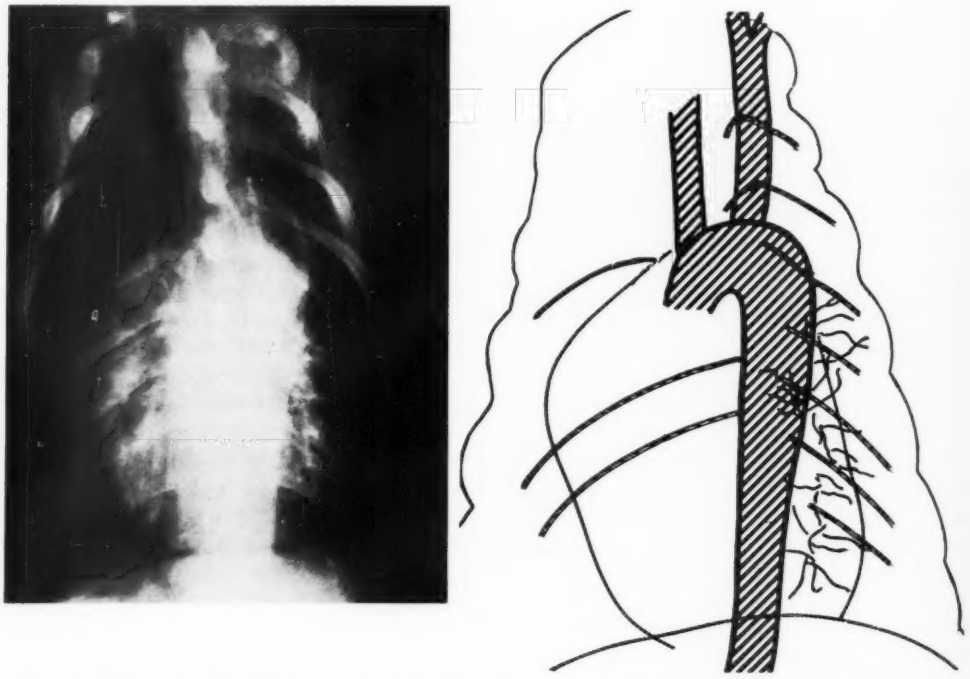

Fig. 6. Retrograde aortogram in a dog following ligation of the left main pulmonary artery, showing good filling of the intercostal arteries bilaterally. Seen best through the left cardiac border is a group of small irregularly distributed vessels (about the size of the intercostal arteries), representing the bronchial arteries.

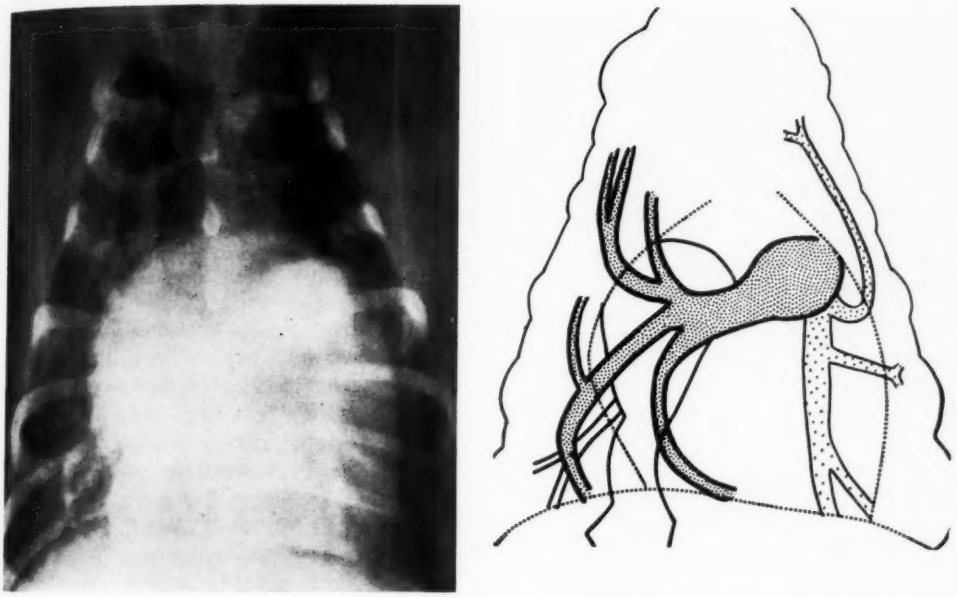

Fig. 7. Venous angiocardiogram of a dog with an anastomosis between the left subclavian artery and the left main pulmonary artery. The film, made during pulmonary artery filling, demonstrates the good visualization of the right pulmonary artery, but on the left the same vessel is poorly filled, even though the two vessels are about the same in caliber. This can probably be explained by the fact that dilution of the left pulmonary artery blood stream has resulted from blood entering it by way of the left subclavian vessel.

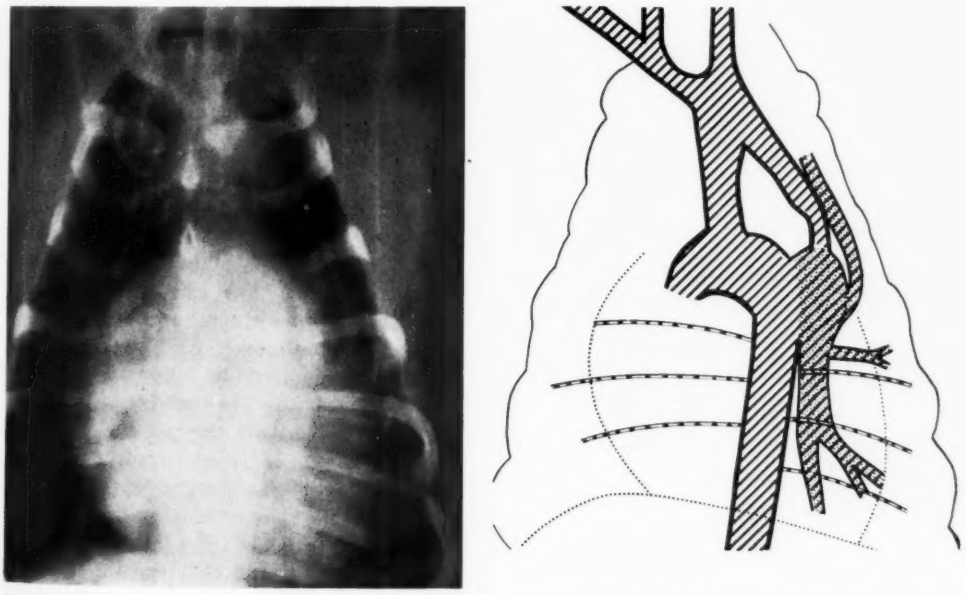

Fig. 8. Retrograde aortogram of a dog that has had an anastomosis of the left subclavian artery and the main pulmonary artery. Contrast material can easily be traced as it fills the pulmonary artery from the systemic vessel.

Fig. 9. Postero-anterior roentgenogram of chest of patient described in text.
Fig. 10. Bronchogram of same patient as in Figure 9, showing abnormal bronchial tree on left.

angiography that a large amount of blood entered the left pulmonary artery from the subclavian artery. The intercostal arteries were easily identified, but no bronchial arteries could be demonstrated.

In all three groups of animals blood gas analyses demonstrated a normal arterial oxygen saturation.

DISCUSSION

The experiments reported here have shown that it is possible to demonstrate the bronchial and pulmonary arterial circulation of the lungs with standard radiographic methods under conditions of atelectasis, pulmonary artery obstruction, and artificial shunt production. These methods and findings can be applied to the evaluation of pulmonary disease in clinical practice.

Liebow, Hales, Bloomer, Harrison, and Lindskog (2, 3, 4) have shown that following ligation of the pulmonary artery in dogs, and in patients with pulmonary stenosis, bronchiectasis, carcinoma, tuberculosis, and emphysema, there is enlargement of the bronchial arteries and their anastomoses with the pulmonary arteries. From such observations, these workers have postulated that extensive communications between the high-pressure bronchial arterial system and the lower-pressure pulmonary arteries lead to reversal of flow in the latter vessels, which helps shunt the blood from the diseased areas of the lung, permitting normal arterial oxygen saturation, which might not be the case if a large nonfunctioning area of the lung were perfused.

In uncomplicated chronic atelectasis, however, no increase in the bronchial arterial collateral circulation is demonstrable by angiography or at operation or autopsy, either in dogs or in man, as we have shown previously(1). The presence of bronchial arterial collaterals when associated with collapse then could be explained by infection of the lung or by obstruction of the pulmonary arteries.

As an example, we have recently encountered several instances of traumatic rupture of a bronchus followed by collapse of the lung for as long as two years. Prior to operation it was difficult to decide whether or not the collapsed lung was diseased, which would strongly influence any decision to anastomose the torn bronchus. One means of evaluating the physiologic status of such a lung is by aortography. If the bronchial arteries are demonstrated, and if the arterial oxygen saturation is abnormal, this would indicate that the lung is diseased, probably infected, and repair of the bronchus would be contraindicated. Lack of visualization of the bronchial arteries and a near normal oxygen saturation would, in contrast, suggest that the lung is

essentially normal, that blood is being shunted from it because of increased pulmonary artery resistance due to collapse, and that repair of the bronchus would probably result in a functioning lung.

By the same token, in a patient with extensive chronic pulmonary disease as seen on plain films but with incomplete collapse of the lung, pulmonary arteriograms demonstrating a lack of perfusion of the arteries on the involved side would be another indication of a severe physiologic deficit in the involved lung. Resection would be feasible in such a patient, even with a diminished pulmonary reserve, since little functioning lung would be sacrificed.

In our hospital the latter problem appears most often in patients with evidence of long standing pulmonary disease, characterized by a small thorax on one side and evidence of fibrosis or "honeycombing" in the lung of that side, associated with infection or bronchiectasis. The diseased lung can usually be identified without difficulty, but the problem is to decide if the contralateral lung is functioning well enough to permit resection of the abnormal lung. This decision can often be made best by pulmonary arteriographic studies, which will show the arteries in the abnormal lung to be diminished in size and number, just as in the chronically collapsed lung. The distended normal lung will show at the same time numerous dilated vessels, similar to those seen in the normal lungs of the dogs with chronic atelectasis.

A few patients evaluated by this means have had excellent recovery following resection of the diseased lung. As an example, Figure 9 shows the admission chest film of a patient referred to us because of an abnormal right lung. Closer inspection reveals the left lung to be the abnormal one; the left thorax is small and there are cystic changes in the lung. Since the abnormality probably had been present since childhood, the radiographic alterations on the right can be explained by compensatory hypertrophy. Bronchograms revealed crowding and nonfilling of the smaller radicles but no bronchiectasis (Fig. 10). The

Fig. 11. Venous angiocardiogram of patient seen in Figures 9 and 10, showing dilated right pulmonary artery and its branches and much smaller branches on the left.

pulmonary arteriograms were helpful in deciding upon a left pneumonectomy. Figure 11 shows the pulmonary arteries on the left to be diminished in size and number while those on the right are dilated throughout the lung. These changes are similar to those seen in the dogs with chronic atelectasis and here confirmed the impression of a normal right lung and a functionally useless left one. The patient has done well following resection of the left lung.

The value of demonstrating the patency of artificial shunts of the Blalock type has obvious applications when the function of the shunt is in doubt. It also demonstrates that the greater part of flow through the shunt is to the ipsilateral lung.

SUMMARY

The performance of venous and aortic angiography to show the arterial circulatory pattern of the lungs provides a simple and relatively safe clinical means for aiding in the evaluation of their functional status.

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School of Medicine
University of North Carolina
Chapel Hill, N. C.

SUMMARIO IN INTERLINGUA

Le Signification de Alterationes del Vasculatura Arterio-Pulmonar

Angiographia venose e aortic esseva executate in canes in que le vasculatura arterio-pulmonar habeva essite alterate in tres manieras: (1) Per transsection e sutura de un broncho principal; (2) per ligation de un major arteria pulmonar; (3) per anastomosis del arteria sinistro-subclavian con le arteria pulmonar (manovra de Blalock).

Iste experimentos provava que il es possibile demonstrar le circulation bronchial e pulmonar per medio de technicas standard de radiographia sub le conditiones de atelectasis, obstruction pulmono-arterial, e shunting artificial. Informationes assi obtenite representa possibilemente un adjuta importante in evalutar le stato functional del pulmones, specialmente in casos in que interventiones chirurgic es contemplate.

(*For Discussion of this paper, see page 17*)

Radiologic Signs of Pericardial Effusion

An Experimental Study[1]

HARRY Z. MELLINS, M.D., PETER KOTTMEIER, M.D., and BRIAN KIELY, M.D.

MANY RADIOLOGIC signs of pericardial effusion have been described. Except for the angiocardiographic signs, all of them fail often enough to leave the radiologist unsure of their value in any particular case. None of them, short of angiocardiography, is based on definite knowledge of the localization of the pericardial fluid, but rather on the total behavior of the central mediastinal shadow.

The study to be reported here was designed to indicate:

(1) Where in the pericardial sac effusion collects.

(2) How it redistributes itself with change in bodily position.

(3) Whether damping of pulsations in specific segments along the edge of the central mediastinal shadow can be related to the presence of pericardial effusion.

MATERIAL AND METHODS

Opaque pericardial effusions in dogs were produced in the following way. A thoracotomy was performed under Pentothal anesthesia. Through a small slit in the pericardium, a polyethylene catheter was inserted into the pericardial cavity; 40–50 c.c. of 70 per cent Diodrast was slowly injected, the catheter was removed, and the pericardial opening was closed by a loop suture. A chest tube was inserted and the chest was closed. After it was seen that the lungs were well expanded and the pericardial closure did not leak, the chest tube was removed. The pericardial fluid increased in amount as the hypertonic contrast medium drew fluid into the cavity.

The dogs were examined fluoroscopically in the recumbent and erect positions and in the four decubitus positions. The esophagus was outlined by a barium swallow.

Fig. 1. Prone film showing fairly even layer of opaque pericardial fluid around the heart. The upper arrow shows the pulsatile heart border; the lower arrow shows the nonpulsatile pericardial border.

The distribution of the fluid and the presence or absence of pulsations along the pericardial borders were noted. The distribution of the opaque effusion was demonstrated on radiographs, and the nature of the pulsations was recorded on roentgen kymograms. Finally cineradiographs using the image intensifier were made.

RESULTS

The opacified pericardial effusion appeared as a dense mantle about the heart when the dog was in the prone or supine projection (Fig. 1). There was no pulsation of any portion of the pericardial border, although the heart had the appearance of a vigorously pulsating polyp within the pericardial sac.

In the lateral recumbent position most

[1] From the Departments of Radiology, Surgery, and Pediatrics of the State University of New York Downstate Medical Center and the Kings County Hospital Center, Brooklyn, N. Y. Presented as part of a Symposium on Cardiovascular Roentgen Diagnosis at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958.

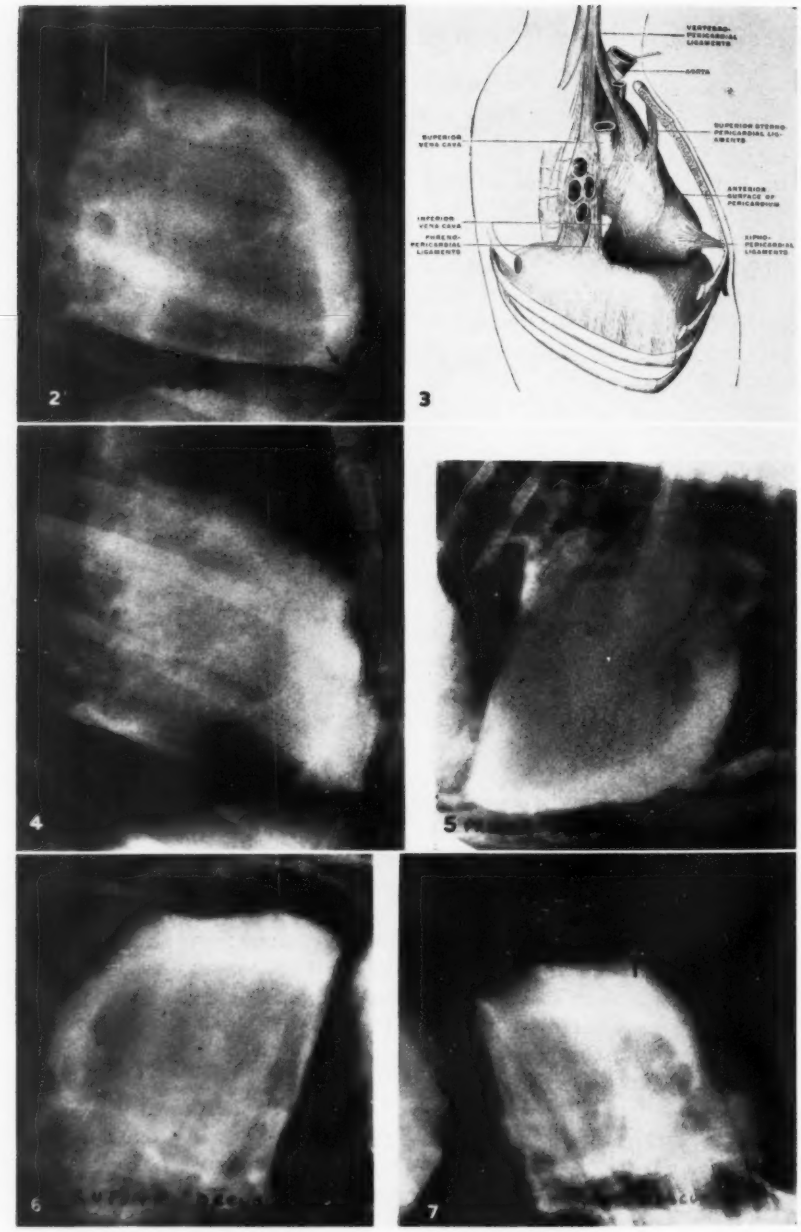


Fig. 2. Recumbent lateral film showing opaque pericardial effusion anterior to the heart. The upper arrow indicates the pericardial recess produced by the superior sternopericardial ligament. The lower arrow indicates the recess produced by the xiphopericardial ligament. Note absence of fluid behind the heart.

Fig. 3. Anatomy of the pericardial ligaments in man (Gray).

Fig. 4. Erect lateral film suggesting somewhat more opaque pericardial fluid anterior to the heart than on the recumbent view (Fig. 2).

Fig. 5. Prone decubitus view showing similar distribution of opaque effusion. Note general similarity of fluid distribution on all lateral films, regardless of effect of gravity.

Fig. 6. Supine decubitus view suggesting somewhat more opaque effusion anterior to heart than in prone decubitus position.

Fig. 7. Supine decubitus view showing attachment of superior sternopericardial ligament.

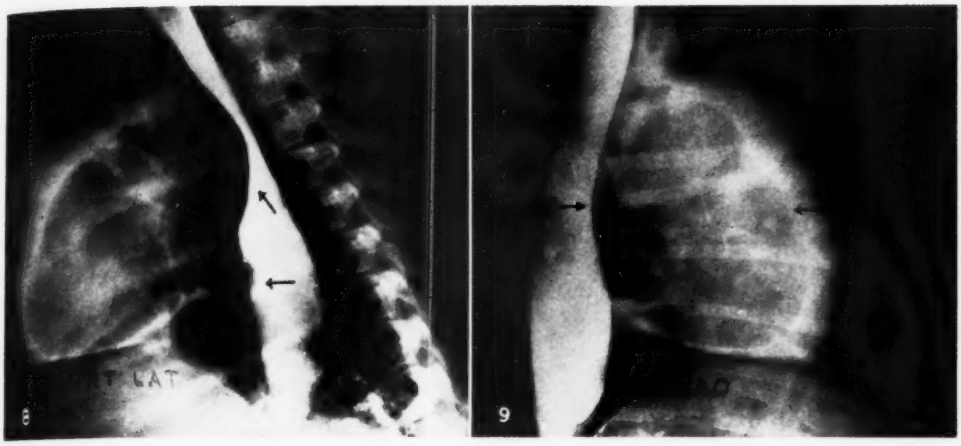


Fig. 8. Right lateral view. The upper arrow indicates the aortic indentation, proportionately larger than in man. The lower arrow indicates the left atrial-pulmonary vein indentation.
Fig. 9. Right anterior oblique view. The left arrow shows the proximity of the esophagus to the posterior surface of the heart. The right arrow shows the anterior surface of the heart within the anterior layer of pericardial effusion.

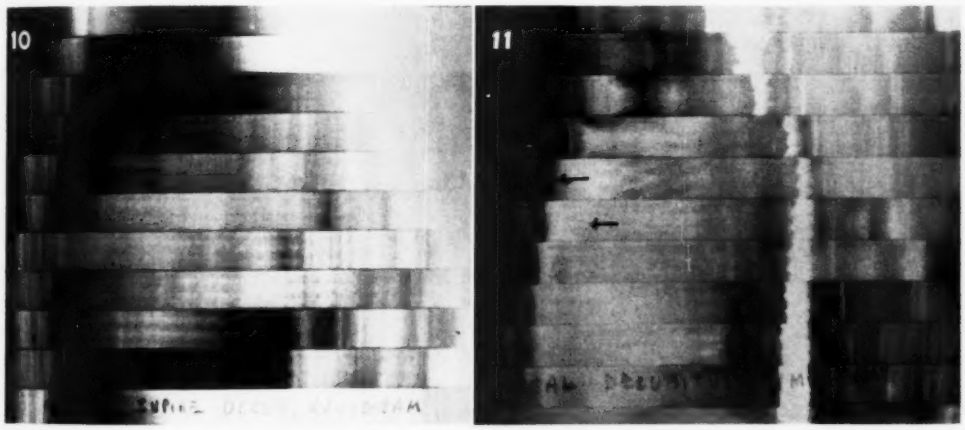


Fig. 10. Normal lateral kymogram. The arrow shows normal pulsation of the anterior cardiac border. (Exposures in Figs. 10 and 11 were made in the supine decubitus position.)
Fig. 11. Lateral kymogram of dog with opaque pericardial effusion. Note cardiac pulsation transmitted to esophagus (lower arrow), active pulsation of anterior heart border (middle arrow), and complete absence of pulsation of anterior pericardial surface (upper arrow).

of the opaque effusion pooled anterior and anterosuperior to the heart, while a small amount appeared inferior to the heart; there was none behind the heart (Fig. 2). The superior sternopericardial ligament and the inferior sternopericardial or xiphopericardial ligament were frequently discernible (Figs. 2 and 3). As seen from the side, the distribution of fluid when the dog was held erect was similar to that seen in the recumbent position, except that, if anything, more fluid collected anterior to the heart (Fig. 4).

Lateral views of the prone (Fig. 5) and supine (Fig. 6) animal showed the same distribution of opaque fluid as in the other positions. There appeared, however, to be slightly more fluid anterior to the heart in the *supine* decubitus view than in the prone decubitus view (Fig. 7).

After it was demonstrated that the observations described above could be con-

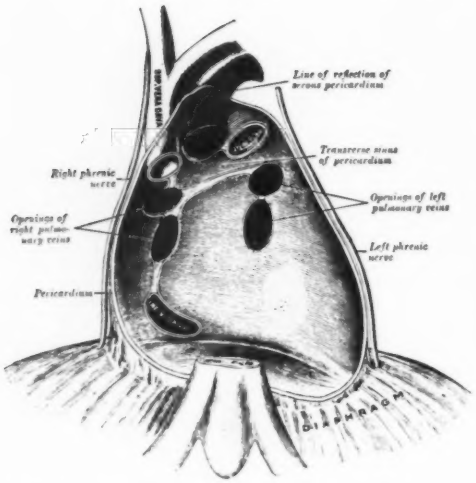


Fig. 12. Anatomy of pericardial reflections in man: pericardial surface (Gray).

sistently reproduced, the pulsations of the central mediastinal shadow were studied. There was full agreement between the fluoroscopic, kymographic, and cinematographic appearances (Figs. 8–11). As seen in the frontal projection there was a decrease or absence of pulsation along the entire pericardial border. In the lateral or anterior oblique views the anterior pericardial surface did not pulsate, while the barium-filled esophagus behind the heart transmitted cardiac pulsations of good force.

Finally, heart failure was produced in dogs by overloading the venous circulation with 2,000 c.c. of blood. Whether the heart responded initially by increased activity or later by dilatation and decreased pulsation, the significant finding was that the pulsations of the anterior surface of the pericardium and posterior surface of the heart were equal.

DISCUSSION

The posterior surface of the heart is fixed to the soft tissues of the posterior mediastinum by the six blood vessels which enter the heart posteriorly—the four pulmonary veins and the two venae cavae. The visceral pericardium closely invests these blood vessels and then is sharply reflected upon itself where it becomes the posterior parietal pericardium. The anatomy of the posterior pericardial reflections in the dog does not differ appreciably from that in man (Figs. 12 and 13).

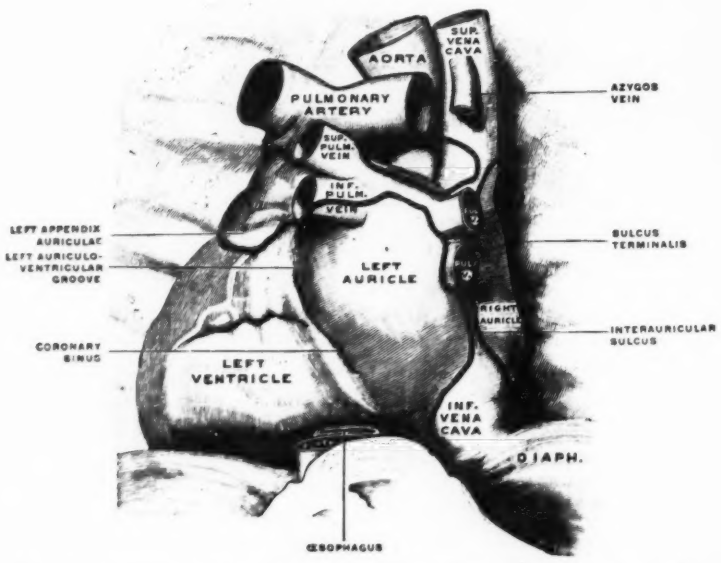
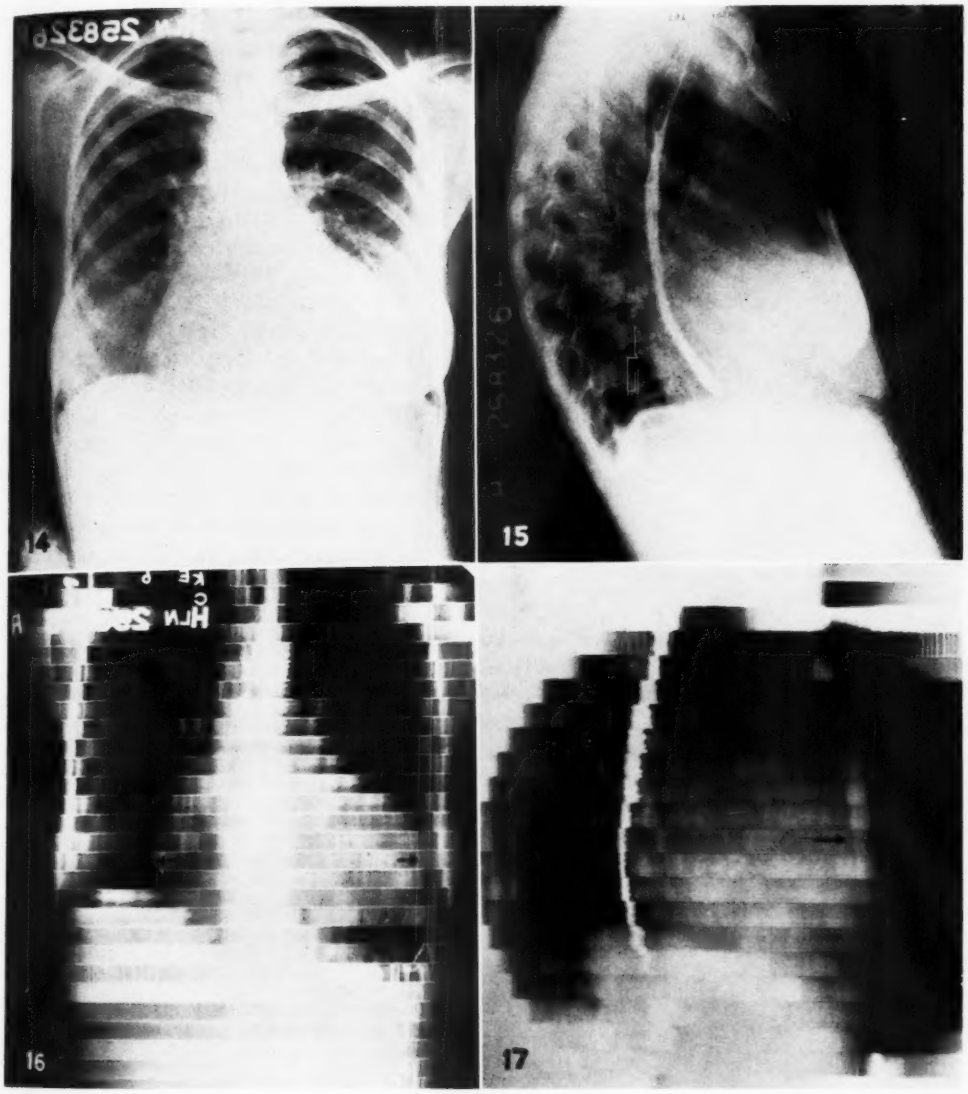


Fig. 13. Anatomy of pericardial reflections in man: posterior cardiac surface (Gray).



Figs. 14–17. Case I.

Fig. 14. Postero-anterior chest film showing nonspecific enlargement of cardiac silhouette with clear lung fields.

Fig. 15. Lateral view. Note obliteration of retrosternal space.

Fig. 16. Postero-anterior upright kymogram showing damping of cardiac pulsations in inferior portions of both lateral heart borders.

Fig. 17. Note absence of pulsation of anterior heart border (arrow), while there is good transmitted pulsation of the barium-filled esophagus.

When the spine is extended or when the animal takes a deep breath, there is traction upon the posterior mediastinum. The posterolateral visceral pericardial surfaces are brought closer to the posterolateral parietal pericardial surfaces, thus decreasing the amount of room available for the accumulation of fluid behind the heart. At the same time, the superior and inferior sternopericardial ligaments maintain or increase the size of the pericardial cavity anteriorly. Fluid is thus effectively squeezed

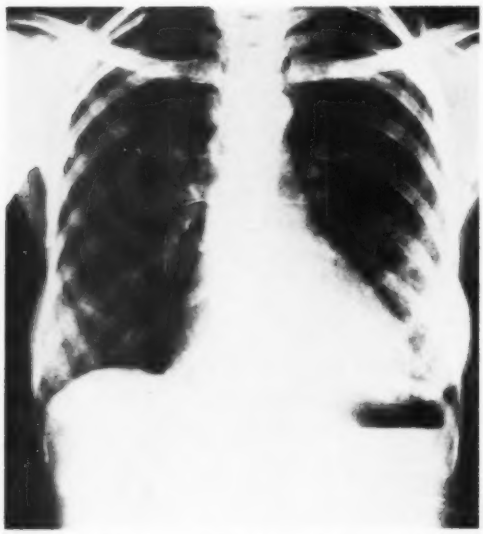
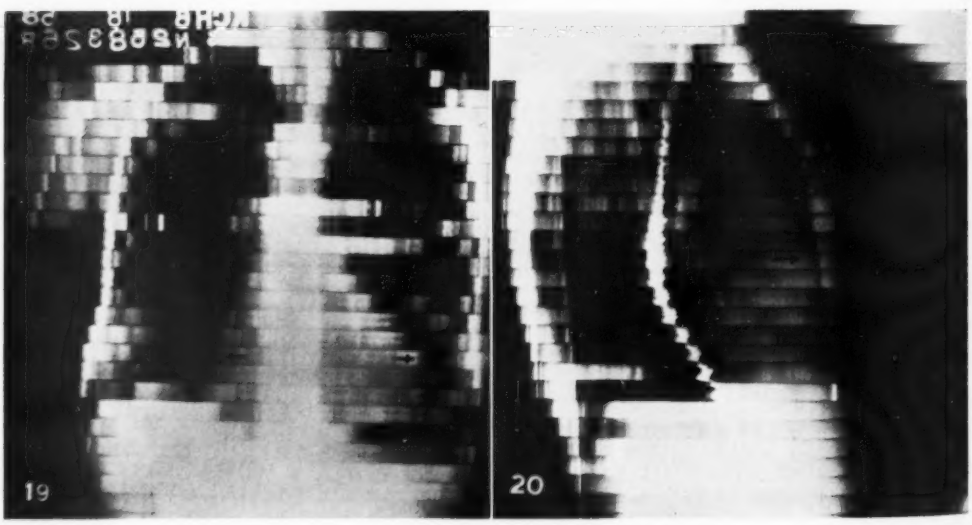


Fig. 18. Case 1. Decided decrease in heart size following corticosteroid therapy.

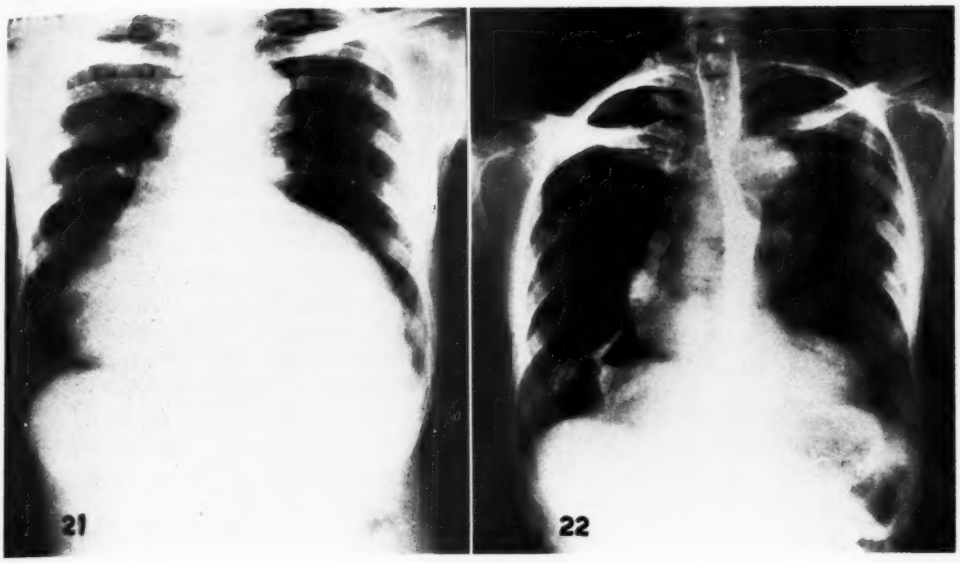
into the anterior portion of the cavity. Possibly this explains the observation that somewhat more opaque effusion was seen anterior to the heart in the erect position than in the recumbent position, and in the supine decubitus view as compared to the prone decubitus view. In both the erect and the supine decubitus positions there is extension of the vertebral column.

In 1950 Golden (1) described obliteration of the retrosternal space, seen on the lateral roentgenogram, as a sign of pericardial effusion. He postulated that the pericardial fluid accumulated anterior to the heart but did not specifically demonstrate this. In 1958, Steinberg, von Gal, and Finby (2) showed by means of angiocardiography that pericardial fluid collected anterior to the heart and displaced the opacified heart chambers posteriorly. The limitation of Golden's sign is that it does not distinguish between right ventricular enlargement and pericardial effusion. The limitation of angiocardiography, using either opaque media or carbon dioxide, as a roentgen diagnostic method for pericardial effusion lies in the admittedly small but real risk of the procedure.

Since the fluid anterior to the heart will damp cardiac pulsations anteriorly while the barium-filled esophagus will transmit cardiac pulsations, we have the basis for a radiographic sign of pericardial effusion based on differential damping of cardiac



Figs. 19 and 20. Case 1. Following corticosteroid therapy cardiac pulsations are seen in inferior portions of both heart borders. Comparison of Fig. 20 with Fig. 17 reveals return of anterior cardiac pulsations following corticosteroid therapy (arrow).



Figs. 21 and 22. Case II.
Fig. 21. Postero-anterior chest film showing decided enlargement of the cardiac silhouette with obliteration of normal cardiac contours and clear lung fields.
Fig. 22. Pneumopericardium after the removal of 700 c.c. of pericardial fluid.

pulsations. This can be registered by roentgenkymography and possibly, as more experience accumulates, by simple fluoroscopy. A lateral kymogram of a normal dog made in the supine decubitus position shows active pulsations both anteriorly and posteriorly (Fig. 10). The lateral kymogram of a dog with opaque pericardial effusion shows a completely nonpulsatile anterior pericardial border, while the anterior border of the heart just beneath it shows good pulsations. The barium-filled esophagus likewise demonstrates active pulsations (Fig. 11).

Early clinical trials are encouraging. A middle-aged woman who entered the hospital because of increasing dyspnea and general malaise was found to have nonspecific enlargement of the cardiac silhouette (Figs. 14 and 15). Fluoroscopy and kymography in the frontal view revealed diminished pulsation of the inferior 1 1/2 to 2 inches of the right and left heart borders (Fig. 16). Lateral fluoroscopy and kymography revealed lack of pulsation of the anterior pericardial surface with good pulsation of the barium-filled esophagus (Fig. 17). Auscultatory and electrocardiographic signs were also suggestive of pericardial effusion, and corticosteroid therapy was instituted. There was prompt improvement and a few days later the heart was decidedly smaller (Fig. 18). Serial fluoroscopic and kymographic examinations demonstrated the return of definite pulsations anteriorly (Figs. 19 and 20).

A second case of interest is that of an elderly woman who had had a bowel resection for carcinoma of the cecum one year before entering the hospital because of anemia and weakness. The postero-anterior chest roentgenogram (Fig. 21) was interpreted as strongly suggestive of pericardial effusion. Since there were no clinical or electrocardiographic signs to support the diagnosis, the Medical Service was reluctant to accept it. Fluoroscopic and kymographic study (Fig. 23) revealed good pulsation of the barium-filled esophagus, with complete damping of cardiac pulsations anteriorly. Pericardiocentesis, with the removal of 700 c.c. of fluid, was followed by the induction of pneu-

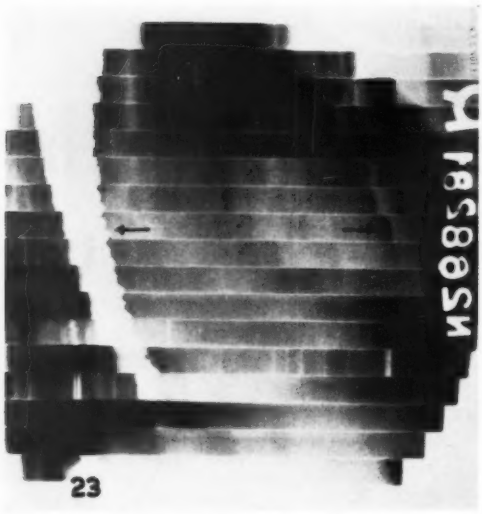


Fig. 23. Case II. Lateral kymogram showing absence of cardiac pulsations anteriorly with normal transmission of pulsations to the esophagus.

mopericardium (Fig. 22). Malignant cells were found in the pericardial fluid.

SUMMARY

Opaque pericardial effusions were produced in dogs and the animals were examined in the recumbent, erect, and four decubitus positions, while the nature of the pulsations was recorded on roentgen kymograms.

The fluid collected anteriorly, superiorly, laterally, and to a lesser degree inferiorly. There was almost no posterior localization of the pericardial fluid. Furthermore, the location of the effusion was not altered to any appreciable degree by a change in position of the animal.

The pulsations of the anterior pericardial surface are damped in pericardial effusion, while there is good transmission of cardiac pulsation to the barium-filled esophagus. In myocardial dilatation the pulsations of both surfaces are roughly equal.

Early clinical trials support the experimental findings.

450 Clarkson Ave.
Brooklyn 3, N. Y.

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SUMMARIO IN INTERLINGUA

Signos Radiologic de Effusion Pericardial: Un Studio Experimental

Opac effusiones pericardiac esseva producite in canes per le injection directe de Diodrast in le cavitate pericardial. Le animales esseva examinate in le position recumbente, le position erecte, e quatro decubitos differente pro determinar le sito del liquido. Le pulsationes esseva registrate per roentgenokymographia.

Esseva trovate que le liquido se habeva accumulate in sitos anterior, superior, lateral, e—minus marcatemente—inferior in relation al sito del corde. Quasi nulle liquido esseva trovate in retro del corde. Le location del effusion non esseva alterate appreciabilemente per alterationes in le position del animales. Le pulsationes del superficie antero-pericardial esseva amortite, durante que bon transmissiones del pulsation cardiac esseva observate in le esophago plenate de barium. Isto es contrari al observationes in dilatation myocardial in que le pulsationes del superficie anterior del pericardio e del superficie posterior del corde es equal.

Le prime essayos clinic ha corroborate le constatationes experimental.

DISCUSSION

(Papers by Sprunt, Peters, and Holder; Mellins, Kottmeier, and Kiely)

Donald E. Cassels, M.D. (Chicago, Ill.): I think it is only fair to say that I would rather have given these papers than discuss them. They are excellent and represent real advances in the areas discussed.

With regard to the paper by Dr. Sprunt and his associates on "The Significance of Alterations in the Lung Arterial Pattern," it seems to me that the procedure described might well be what the authors suggest, a way to diagnose chronic lung diseases, noting the reciprocal relationships between the pulmonary artery flow and the bronchial artery flow. However, some clinical confirmation is necessary. I also think that enough radiological manipulation is required so that the method would be applicable in isolated or other selected cases. I am sure that this procedure is applicable clinically and perhaps the authors will report on this at some later date. The problem of proper opacification of the bronchial artery is an important and difficult one.

In reference to Dr. Mellins' paper, I have little to add. I would hope that the experimental data in connection with animals will also hold in man. I have put needles into heart chambers many times, both on the advice of roentgenologists and without their advice and I certainly agree, as a clinician, that identification of pericardial effusion is extraordinarily difficult.

These data would raise the question whether the authors happened to have just the right amount of fluid to demonstrate and whether, if they had used twice the amount, the demonstration would perhaps not have been quite so evident.

I can state from personal observation that the larger pericardial effusions can be tapped posteriorly. I will follow with great interest evidence of this in connection with a series of clinical observations.

Suprasternal Thoracic Aortography

Suprasternal Transthoracic Needle Puncture Opacification of the Thoracic Aorta[1]

I. STAUFFER LEHMAN, M.D., WILLIAM M. LEMMON, M.D., RANDAL A. BOYER, M.D., and EDWARD A. FITCH, M.D.[2]

DIRECT OPACIFICATION of the thoracic aorta has engaged the attention of many workers interested in the roentgen evaluation of the cardiovascular system. While aortic opacification may be accomplished by angiocardiography (1), the dilution of the radiopaque medium which occurs during its passage through the right heart chambers, pulmonary circulatory system, and left heart chambers is frequently of such degree that satisfactory visualization is not achieved. This is particularly true in situations where there is either increased pulmonary vascular volume or an increase in the size of the heart chambers such as exists with certain cardiac valvular lesions.

Catheter thoracic aortography (2), with direct delivery of the opacifying agent into the thoracic aorta, does regularly effect satisfactory aortic opacification. The procedure, however, requires introduction of a catheter into a peripheral artery and its advancement to a desired position in the aorta. Surgical repair of the vessel opening through which the catheter is introduced may result in actual closure of the arterial lumen, and undesirable sequelae may follow.

Stimulated by our past experience with cardiac ventriculography (direct transthoracic needle puncture opacification of the ventricular chambers of the heart) (3), we have evolved a procedure of transthoracic needle puncture of the ascending aorta, with rapid injection of a high-concentrate radiopaque medium through the needle to effect direct opacification of the thoracic aorta. Since we utilize a suprasternal approach for the needle introduction, we have elected to term the procedure, "suprasternal thoracic aortography." Thus far, we have employed it for the demonstration of aortic valvular lesions, particularly aortic valvular insufficiency; evaluation of suspected patent ductus arteriosus, and also as a means of effecting coronary arterial opacification. When performed specifically for coronary artery visualization, the procedure has been identified by the term, "suprasternal transaortic coronary arteriography," and a communication describing our experiences with coronary visualization by this means has been submitted for publication elsewhere.

It is our present purpose to review previous efforts at needle puncture opacification of the thoracic aorta, and to describe in some detail our procedure and technic, with the results obtained in our total experience with suprasternal thoracic aortography.

HISTORICAL

In 1936, Nuvoli (4) reported a successful needle puncture injection of a sodium iodide solution into the left ventricle and the ascending aorta of a patient, by way of an intercostal approach.

Radner (5), in 1945, described the insertion of a needle through the sternum into the ascending aorta, with injection of a radiopaque medium to obtain aortic and coronary artery opacification. In 5 performances he met with 2 complications. Only faint visualization of the proximal portions of the coronary arteries was ob-

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Presented as part of a Symposium on Cardiovascular Roentgen Diagnosis at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958.

[2] Public Health Service Research Fellow, National Heart Institute.

tained. In another report, in 1954, Radner (6) described a procedure in which he employed a suprasternal approach for intrathoracic needle puncture of the left atrium and the ascending aorta, for the purpose of recording left atrial and aortic pressures. There was no injection of opaque medium nor any attempt at opacification. This article suggested to us the feasibility of suprasternal needle puncture opacification technics.

Hoyos and Del Campo (7), in 1948, reported opacification of the thoracic aorta and the coronary arteries, using a left parasternal needle puncture of the ascending aorta.

The first reference to a suprasternal type of approach for thoracic aortography which we have encountered is that of Wickbom (8), in 1952. His report on thoracic aortography after direct puncture of the aorta from the jugulum deals with puncture of the aortic arch. No mention is made of attempted advancement of the needle to place its tip in the proximal portion of the ascending aorta near the level of the aortic sinuses. Opacification of the aorta and its branches was described and 8 cases were reported. Coronary artery opacification is not mentioned except in connection with one fatality resulting from the procedure (9).

Eiseman and Rainer (10), in 1955, described a procedure of thoracic aortography by needle puncture of the aortic arch, with introduction of the needle into the thorax at the midclavicular line, 1.0 cm. above the right clavicle. These authors report opacification of the aorta from its arch to the diaphragm, but not of the ascending aorta. In fact, they concluded that contrast perfusion of the coronary arteries is to be avoided.

METHODS AND MATERIALS

In the development of our technic for suprasternal thoracic aortography, we have relied heavily upon our experience with cardiac ventriculography (3) and have adapted to our procedure for needle puncture opacification of the thoracic aorta essentially the same equipment and materials which we utilize for transthoracic needle puncture of the left (or right) ventricle.

The proper performance of suprasternal thoracic aortography (or its component suprasternal transaortic coronary arteriography) requires a well trained and well co-ordinated team, under the direction of a radiologist. It is our strong conviction that the procedure should not be undertaken until *all* personnel of the team are thoroughly versed in their respective duties and responsibilities. Since electrocardiographic and manometric pressure monitoring is decisive for successful and satisfactory radiopaque medium injection, the radiologist in charge should be conversant with the equipment for such recordings and with the recordings themselves. He should be prepared to decide upon termination of the procedure should the recordings or the patient's condition so indicate. For the electrocardiographic and manometric pressure monitoring a cardiophysiologist is an important member of the team. The actual needle puncture of the aorta should, in our opinion, be executed by a thoracic surgeon prepared to deal with all possible emergencies incident to intrathoracic needle passage. An anesthesiologist is also essential, to lend immediate aid in event of unexpected emergency.

We employ a 17-gauge, thin-wall needle of 7-inch length. In our initial studies, an open-end needle was used, but we are currently using a closed-end needle with a single side hole opening opposite the beveled side and located immediately adjacent to the closed end. The needle is of moderate bevel and is connected by a 14-inch length of special high-burst strength (but reasonably flexible) plastic tubing to a special large-bore three-way stopcock. From the stopcock the system is connected by a 40-inch length of plastic tubing of high-burst strength to a pressure injection apparatus. The needle, tubing, and stopcock assembly was initially designed for our cardiac ventriculography studies and has been termed the cardiac

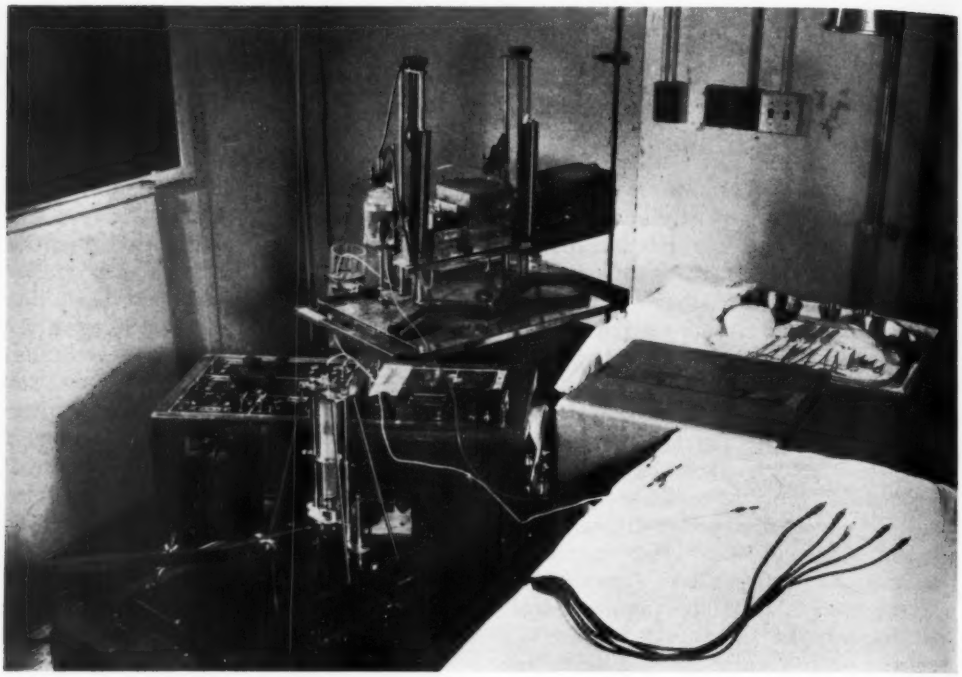

Fig. 1. Basic equipment for suprasternal thoracic aortography.

ventriculography assembly.[3] The three-way stopcock is also connected by tubing to a capacitance-type electromanometer and direct writing polyoscillograph.[4] Pressure tracing and electrocardiographic monitoring are simultaneously recorded.

Rapid serial filming on films of a size sufficiently large to permit inclusion of the entire heart and thoracic aorta is essential. A filming rate of at least 2 per second for 6 seconds is recommended. Figure 1 illustrates the set-up.

We have used a diatrizoate methylglucamine radiopaque medium—Hypaque[5] or Cardiografin[6]—in either 85 per cent or 90 per cent concentrations and have found both of these to be satisfactory. Since these agents are substances of considerable viscosity, it is advantageous to warm them to facilitate their flow through the tubing assembly and needle. We have accomplished this by directing the rays of a heat lamp of the bulb type toward the filled injecting syringe. The amount of medium injected has varied with weight and habitus of the patient, the usual adult dose ranging from 30 to 40 c.c.

All of our suprasternal thoracic aortographies have been performed with the patient in supine position, head and chin rotated to the right. The patient is so positioned that the cephalic margin of the shoulders is at the edge of the rapid film changer, and the head is actually suspended over the changer in a position of marked extension.

A strip of tape to which are attached leaded numerals, 1.0 cm. apart, is placed over the sternum, extending from the suprasternal notch to slightly above the xiphoid process. Secured to the same strip is a malleable needle, 7 inches long, with its hub at the suprasternal notch, as illustrated in Figure 2. The x-ray tube is centered over the midpoint of the

[3] George P. Pilling and Sons, Philadelphia, Penna.
[4] Obtained from Sanborn Company, Cambridge, Mass.
[5] Winthrop Laboratories, New York, N. Y.
[6] E. R. Squibb & Sons, New Brunswick, N. J.

sternum, and several scout films are obtained at varying exposure factors. Decisions regarding the approximate level of the aortic sinuses, the position of the ascending aorta, and the most suitable roentgenographic factors are reached from study of these films and conventional preliminary chest films (postero-anterior, lateral, and right and left anterior oblique projections). From the projection of the lead numbers on the scout films, the approximate level of the aortic sinuses is ink-marked on the patient's skin. The distance of needle insertion required to reach from the suprasternal notch to a point just above the aortic sinuses is determined from the image of the 7-inch malleable needle. It is our impression that the actual roentgen exposures should not exceed 1/30 second each.

Some type of premedication is advisable for mild sedation and alleviation of any pain incident to the procedure. It has been our practice to administer to the average adult patient, 100 mg. of pentobarbital orally one hour prior to the examination; one-half hour later 50–100 mg. of meperidine is given intramuscularly, and atropine, 0.4–0.6 mg.

After preliminary intradermal radiopaque skin testing for evidence of sensitivity to the opaque medium, and with the patient positioned as previously described, a short run of electrocardiographic record is made. The neck and anterior chest wall are prepared with an appropriate skin antiseptic, from the level of the mandible to the xiphoid process. The head, neck, and chest are properly draped. At a selected site, some 2.0 to 4.0 cm. above the suprasternal notch in the midline of the neck, a lidocaine wheal is made and the lidocaine (Xylocaine) local anesthesia extended below the suprasternal notch following the course of the aortic needle passage. A cutaneous stab wound is made with a No. 15 knife blade at the site of the skin wheal. While a dribble of physiological saline is flowing from the electromanometer through it, the needle is passed in a midline direction behind the manubrium of the sternum and aimed toward the ascending aorta.

Fig. 2. Preliminary film. Strip of lead numerals and 7-inch malleable needle taped over sternum. Estimation of depth of needle insertion is determined from this film.

The slow flow of saline solution is shut off and the electromanometer is now ready to record pressure waves. The polyoscillograph recording the electrocardiogram and the pressure monitoring is adjusted to running position. The needle is slowly advanced until aortic pulsations are felt through it, as its tip encounters the aortic wall. With a short, quick thrust, penetration of the aortic wall is accomplished. If a clear, undamped aortic pressure tracing is recorded, the needle is advanced down the ascending aorta for a predetermined distance (previously estimated as placing the needle tip 1.0 to 2.0 cm. above the aortic sinuses). Needle advancement should be performed slowly, with attention to the tactile sense of resistance and to transmitted pulsations. If resistance is encountered, or if there is change in the pulsatory movement, such as might occur from a "flip" of a valve cusp upon the needle tip, discreet withdrawal of the needle a distance of 2.0 to 3.0 cm. is indicated. Figure 3 illustrates

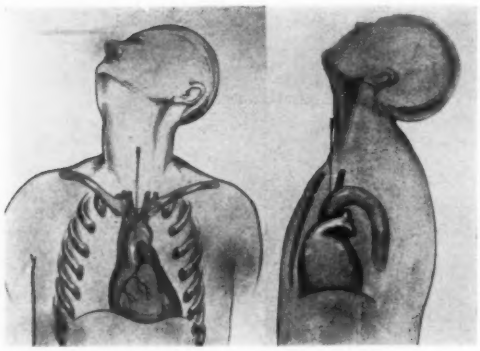

Fig. 3. Diagrams of needle insertion.

diagrammatically the intra-aortic needle insertion.

In the event of any damping of the pressure wave tracings, the needle is slightly retracted or completely withdrawn. Radiopaque injection is considered hazardous unless the needle can be advanced or retracted at least 2.0 cm. without pressure wave damping. If the pressure tracing suggests that the needle has penetrated a vascular structure other than the aorta, such as the pulmonary artery, left atrium, right atrium, or superior vena cava, the needle is immediately withdrawn and decision made as to its further passage. If, from pressure wave tracings, there is any question as to position of the needle tip, it has been our recent practice to expose a single film, withdraw the needle, process the film and, upon viewing the wet film, make a decision as to direction of needle re-insertion. After the needle has been advanced the predetermined distance, with undamped central aortic pressure waves recorded and no persistent electrocardiographic disturbances, the stopcock is adjusted to connect the loaded syringe with the needle. The patient is immediately instructed to stop breathing, and the predetermined amount of radiopaque medium is rapidly injected (in two seconds or, at most, three seconds). The needle is promptly withdrawn upon completion of the injection. The filming sequence is started so that the first film is obtained immediately preceding the injection.

For use in the management of reactions or complications, we have on hand a laryngoscope, endotracheal tubes, thoracotomy tray, cardiac defibrillators, and cardiac pace-maker, and the following drugs: Benadryl, epinephrine, atropine, Prostigmine, Levophed, calcium chloride, procaine, Pentothal, and 5 per cent glucose in distilled water.

ANALYSIS OF CASES AND RESULTS

One hundred and ten attempts at opacification of the aorta in 93 patients by our procedure of suprasternal thoracic aortography and its component, suprasternal transaortic coronary arteriography, form the basis of this report. This is our total experience except for 19 studies in which an identical suprasternal needle puncture opacification technic was used, but with the addition of pharmacologically induced cardiac arrest for the purpose of achieving improved coronary arterial visualization. In the latter 19 studies, we utilized acetylcholine as the agent to induce temporary cardiac arrest, and we have termed this procedure, "cardiac arrest coronary arteriography." Our experience with this newer technic will be the subject of another paper.

Of the 93 patients included in this report, 66 were males and 27 were females. The age range was from fourteen to sixty years, except for 1 patient aged three years. There were 3 patients in their "teens," and 8 were between twenty and thirty years of age.

Radiopaque medium was injected in 84 of the 110 attempted examinations. The remaining 26 examinations were uncompleted because of failure to obtain electromanometric evidence of satisfactory needle penetration into the lumen of the ascending aorta. Of the 84 examinations in which injection was made, aortic opacification resulted in all but 6. In 3 of these, aortic injection was achieved but, because of radiographic or seriographic equipment failure, we obtained no film studies. In 2 examinations the needle was considered to be in the ascending aorta but films revealed

it to be in the main pulmonary artery in 1 and in the right pulmonary artery in the other, and unintentional pulmonary arterial opacification resulted. In the remaining examination, our only attempted study in a child, we were unable to obtain aortic needle puncture but did enter a vascular structure thought, from the pressure waves recorded, to be probably a pulmonary artery. Radiopaque medium was injected, and film studies revealed that the needle had entered the right ventricle. Further details of this examination are outlined later in this paper.

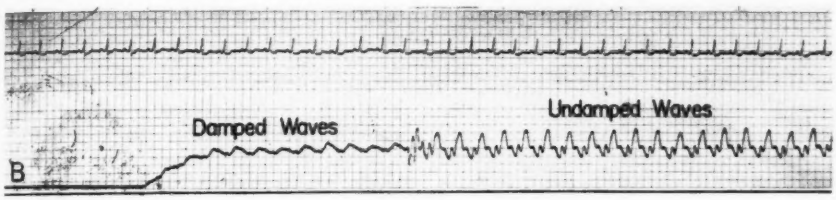

Fig. 4. Aortic pressure and electrocardiographic tracings. Aortic pressure waves initially damped. With needle adjustment, undamped waves are recorded.

Of the 78 examinations in which there were aortic injection and filming, satisfactory needle penetration was accomplished with one needle pass in 46; in 14 studies two needle passes were required to effect aortic puncture; in 9, three passes, and in 8, four passes were necessary. While it is our present policy not to exceed four needle passes, in the earlier of our studies we permitted five needle insertions on one occasion and seven on another to effect aortic puncture. In the 78 examinations, the needle tip was located at the level of the aortic sinuses in 12; above the sinuses but in the proximal third of the ascending aorta in 39; in the middle third in 23; and in the upper third of the ascending aorta on 4 occasions.

Among the 32 examinations necessitating more than one needle pass to obtain aortic puncture, the pulmonary artery was momentarily entered (as adjudged by pressure recordings) on 3 occasions. Unquestionably, there have been instances in which there was transient needle entry into a venous structure, either the innominate vein or the superior vena cava. Pressure recordings indicate that this happened at least 8 times, but the low amplitude of such pressure waves makes their identification difficult, and the frequency of such venous entry is not fully determinate.

Seventeen of the 110 studies were "repeat" procedures. In 9 of these, the second examination was performed because of previous failure to effect penetration of the aorta. In 3 patients, the earlier study was repeated because the first had not yielded satisfactory visualization of the coronary arteries. In 2 patients there was marked dilatation of the ascending aorta and because of dilution of the medium a second attempt was made with a larger amount of radiopaque substance. One study was repeated for determination of the patency of the internal mammary artery following surgical implantation of that vessel into the myocardium (Vineberg procedure); another study was repeated because of seriographic equipment failure on the first examination. The final "repeat" was because of collapse of the injecting syringe, which resulted in delivery of an inadequate amount of radiopaque medium.

Of the 110 examinations, 68 were performed for demonstration of the presence and/or degree of aortic valvular insufficiency, 38 for the primary purpose of determining the status of the coronary arterial system, and the remaining 4 for evaluation of suspected patent ductus arteriosus.

Pressure Recordings: As indicated in the section on Methods and Materials, needle entry into the aorta was determined primarily by continuous electromanometric

monitoring during the intrathoracic insertion of the needle. The pressure wave recordings formed the basis for establishing whether the tip was entirely within the aortic lumen.

During needle advancement to place its tip slightly above the level of the aortic sinuses, continuous observation of the pressure recordings is mandatory to insure that the tip has not impinged upon the aortic wall. As previously mentioned, any damping of the pressure waves is evidence that the tip is not cleanly in the aortic lumen and is an indication for adjustment of needle position. Figure 4 is a "damped" aortic pressure tracing caused by contact of the needle tip with the aortic wall, with a change to an "undamped" wave form following adjustment of the needle.

Knowledge of the sphygmomanometric blood pressure as regularly recorded is an important aid in determining whether the needle tip is actually in the aorta and not in the pulmonary artery, although in 1 of the 2 inadvertent pulmonary arterial injections the pressures recorded in the pulmonary artery were 100 mm. Hg systolic, and 48 mm. Hg diastolic; in another patient, the pressures of 64 mm. Hg systolic and 12 mm. Hg diastolic were incorrectly interpreted. An elevated pulmonary arterial pressure (pulmonary hypertension) may mislead one into the belief that the aorta has been penetrated.

In our 78 aortic opacifications, pressure recordings ranged from 70 to 212 mm. Hg systolic. The highest diastolic aortic pressure recorded was 112 mm. Hg, while the lowest was 20 mm. Hg. The widest pulse pressure recorded in the aorta was 150 mm. Hg (200/50).

Simultaneous aortic and left ventricular pressure recordings were made in 17 of our total studies for the purpose of evaluating the presence of any gradient of pressure differential across the aortic valve in the quantitation of aortic stenosis. These simultaneous recordings were obtained by first effecting needle puncture of the ascending aorta and, with the aortic needle remaining *in situ*, quickly performing transthoracic needle puncture of the left ventricle *via* a subxiphoid approach, in the manner described for cardiac ventriculography. In such studies we used two electromanometers to record the aortic and left ventricular pressures simultaneously on two separate channels of the direct-writing polyoscillograph. A report on these 17 cases and more recent studies is being prepared for publication.

Electrocardiographic Observations: Needle puncture of the ascending aorta can produce disturbances of cardiac rate and rhythm. Among the 110 examinations with intramediastinal insertion of a needle by suprasternal approach, there were 30 instances in which there was some alteration or alterations of the electrocardiographic tracing during the insertion. On certain occasions, such electrocardiographic changes may have involved both rate and rhythm as, for example, the production of sinus tachycardia and also ventricular premature beats. The most frequent electrocardiographic aberration was the occurrence of occasional premature ventricular beats (13 occasions). Occasional premature atrial beats were noted in 10 instances; there was a single premature ventricular beat during needle insertion in 7 instances, while one or more short runs of ventricular tachycardia were encountered in 4 examinations. There were 4 instances of sinus bradycardia and 1 each of a single premature atrial beat, frequent ventricular premature beats, slight sinus tachycardia, moderate sinus tachycardia, and ST segment elevation. There was also one occasion of coupling.

At injection of radiopaque medium, alterations in the electrocardiographic tracings were somewhat less frequent. Sinus bradycardia was observed 5 times; slight sinus tachycardia, 4 times; there was 1 occasion each of a single premature ventricular beat, occasional premature ventricular beats, a short run of ventricular tachycardia, and a short period of sinus arrest.

In the post-injection period, slight sinus tachycardia was the most frequent obser-

vation (31 times). Moderate sinus tachycardia was recorded on 20 occasions, and a rather marked sinus tachycardia on 2. Such sinus tachycardia was preceded by a two- to six-second bradycardia on 15 occasions. T wave flattening was noted 14 times, and definite inversion of the T-wave occurred 11 times. These T wave changes we attribute to momentary myocardial ischemia incident to filling of the coronary arteries with radiopaque medium. The T wave and the ST segment changes have all been of quite short duration, rarely lasting more than fifteen seconds and, on all occasions, reverting to a pre-injection pattern and level.

There was a single instance of delayed interventricular conduction which occurred immediately after radiopaque injection. This was in the three-year-old child, who is mentioned elsewhere in this report. The medium was inadvertently injected into the right ventricle, with a small amount infiltrating the right ventricular myocardium. Such infiltration undoubtedly accounted for the interference with conduction.

Vagal arrest with a six-second period of cardiac asystole occurred in 1 patient, followed by nodal bradycardia. Peculiarly enough, this asystole occurred three minutes after completion of the filming procedure.

Other, less frequent, electrocardiographic changes during the post-injection period are recorded in Table I. This table summarizes all of the electrocardiographic alterations which occurred at needle insertion, during opaque injection, and in the post-injection period.

TABLE I: ELECTROCARDIOGRAPHIC CHANGES
Disturbances of Rate, Rhythm or Conduction Incident to Suprasternal Thoracic Aortography

Nature of Change	At Needle Pass	At Injection	Post-Injection
Single atrial premature beat	1	...	4
Occasional atrial premature beats	10	...	1
Single ventricular premature beat	7	1	1
Occasional ventricular premature beats	13	1	5
Frequent ventricular premature beats	1	...	1
Sinus tachycardia, slight	1	4	31
Sinus tachycardia, moderate	1	...	20
Sinus tachycardia, marked	...	...	2
Sinus bradycardia	4	5	15
Nodal bradycardia	...	...	2
Ventricular tachycardia	4	1	1
ST segment elevation	1	...	1
ST segment depression	...	...	2
T wave flattening	...	4	14
T wave inversion	...	...	11
Coupling	1	...	2
Nodal escape	...	...	1
Sinus arrest	...	1	1
Delayed interventricular conduction	...	...	1
Asystole (6 seconds)	...	...	1

Reactions and Complications: The high concentrate radiopaque solutions currently in use for vascular opacification studies may produce some systemic reaction if the medium enters the cerebral circulation in sufficient amount and concentration. Such reactions have been noted in angiocardiography (11) and in cardiac ventriculography (3). As with cardiac ventriculography, the procedure of suprasternal thoracic aortography does permit a considerable quantity of a rather highly concentrated radiopaque medium to enter the brachiocephalic vessels and the cerebral circulation. However, we have observed no evidence of cerebral dysfunction or cerebral damage of even the slightest degree among our patients.

Practically all of the patients experienced a sensation of heat, usually distributed to the face, neck, chest, and upper extremities, although it was not unusual for this to be felt through the abdomen and pelvis and down to the feet. Flushing of the face and neck was observed with some frequency. Most of the patients complained of slight to moderate substernal discomfort, which lasted a variable length of time, usually less than twenty-four hours. Occasionally this was more severe, extending over several days, and 1 patient suffered continuing discomfort for a full week.

Except for important complications incident to the procedure in 7 cases, to be described later, other reactions noted were: mild to moderately severe headache, usu-

ally frontal in location and generally of short duration (in no case lasting more than thirty minutes), observed on 10 occasions; a short period of nausea, recorded 8 times; shortness of breath, 3 times; slight vomiting twice; jaw pain, twice; shoulder and back pain, twice; some urticarial hives, twice. All of the aforementioned reactions were of short duration.

Three of the 7 important complications were moderate to severe shock. In 1 case the aortic opacification study was uneventful except that immediately after injection of the medium there was a five-second period of marked bradycardia with two premature ventricular beats. This was followed by sinus tachycardia. The patient experienced the usual sense of heat about the head, neck, and chest, and also had a moderately severe headache for ten minutes. Twenty minutes following completion of the injection, he became pale and was momentarily syncopic. Systemic blood pressure fell to 70 mm. Hg systolic. Response to atropine and intravenous 5 per cent dextrose was satisfactory and the patient was returned to his room forty minutes later in a state of good recovery.

The second complication was in a patient whose first examination was unsatisfactory because of seriographic equipment failure, and who had a second uneventful procedure thirteen days later. Six hours following this, however, there was a sudden onset of severe substernal pain, accompanied by moderate shock. The patient responded to the usual measures and the chest pain subsided in about one hour. An electrocardiogram revealed no changes related to this reaction.

The third patient had an unsatisfactory aortic opacification. The stopcock in the tubing assembly was incompletely turned to injecting position, and only a small quantity of the medium entered the aorta, the major portion escaping *via* the three-way stopcock. Three minutes after filming was completed, the electrocardiographic monitoring revealed vagal arrest with cardiac asystole of approximately six seconds duration. The patient complained of severe substernal distress and become syncopic. An intratracheal tube was introduced and oxygen administered. Blood pressure dropped to practically zero. With intravenous dextrose and Levophed, blood pressure returned to normal and the patient fully reacted in about thirty minutes, continuing, however, to complain of substernal distress. Renal shutdown occurred the following day and was of somewhat serious degree for five days, with gradual, complete recovery.

A fourth complication occurred in a patient in whom the procedure was not completed, three needle passes having failed to accomplish aortic penetration. After the third needle pass, the patient gave evidence of slight shock and mild dyspnea. Blood pressure fell to 70 mm. Hg systolic, and a bradycardia of sixty beats per minute was recorded. A film of the chest revealed a small (approximately 20 per cent) pneumothorax on the right. This required no treatment and the patient recovered from his mild shock in three hours.

Our fifth complication was incident to a combined subxiphoid puncture of the left ventricle and suprasternal needle puncture of the aorta, to obtain aortic and left ventricular pressures and any gradient of pressure difference across the aortic valve. This was followed by opaque medium injection into the ascending aorta for quantitation of any existing aortic insufficiency. Shortly after the injection, the patient went into mild shock and had two clonic *grand mal* seizures of approximately one minute duration each, about four and seven minutes post-injection. A history of previous similar attacks was obtained, the last having occurred one week before the procedure. Response to the usual treatment for shock was entirely satisfactory, with return to the pre-examination status the following day.

A patient whose successful examination for quantitation of aortic insufficiency required two needle passes presented our

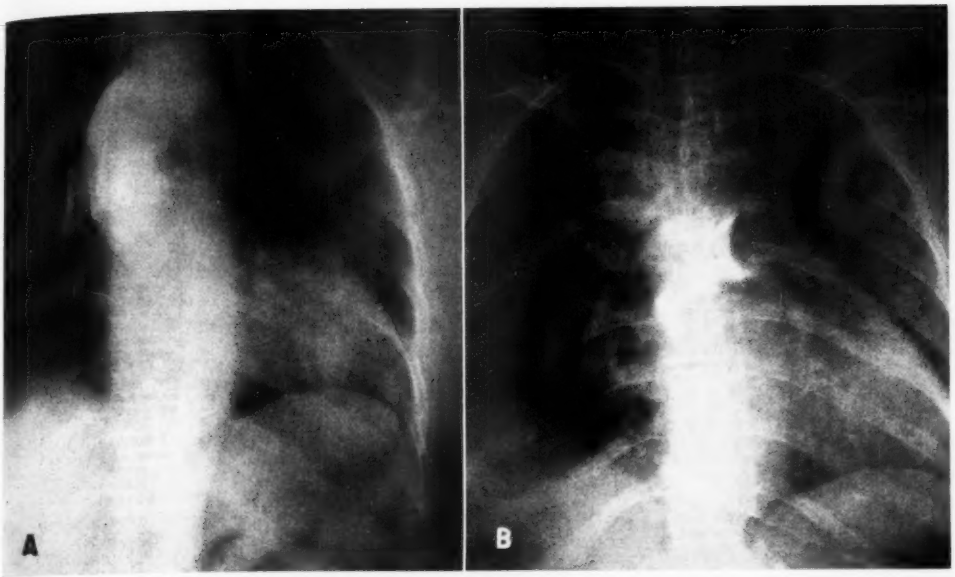

Fig. 5. Inadvertent partial para-aortic injection. A. Infiltration of aortic wall, with extension of small quantity of opaque medium into para-aortic tissues. B. Fifteen minutes later: residual intramural and para-aortic medium. Note small amount of intrapericardial medium.

sixth complication. This patient initially experienced nothing more than the usual sensation of heat and slight substernal discomfort. Film studies revealed a three plus regurgitant opacification of the left ventricle. The substernal distress persisted for three days, with fever and electrocardiographic evidence of an acute pericarditis. At open-heart surgery for correction of the aortic insufficiency four days following aortography, a moderate amount (not estimated) of bloody fluid was found in the pericardial sac.

The final definite complication consisted of partial para-aortic injection of the radiopaque medium. Puncture of the aorta was accomplished with one needle insertion, with the tip positioned 1.5 cm. above the level of the aortic sinuses. Clear, undamped aortic pressure waves were recorded, but at injection approximately 40 per cent of the 35 c.c. dosage of opaque medium entered the para-aortic tissues, with a minimal amount observed in the pericardial sac. The aortic lumen was fairly well opacified. Presumably, during injection there was momentary thrust of the needle through the aortic wall by some mechanism which we cannot explain. The patient experienced a burning sensation in the superior mediastinal region and complained of some pain in this area for twenty-four hours. Illustration of this partial para-aortic injection is shown in Figure 5.

In addition to the aforementioned reactions and complications, 1 patient displayed moderate hypotension following two unsuccessful needle insertions; another experienced slight shock with syncope four minutes after completion of an uneventful aortic opacification. Both of these patients responded to atropine and intravenous fluids with Levophed. Another patient exhibited symptoms of slight hypotension after three unsuccessful needle passes but required no treatment other than a short period of oxygen administration.

The only child in the series, a boy three years of age, was the subject of an attempt at suprasternal thoracic aortography under general anesthesia, for the demonstration of suspected patent ductus arter-

Fig. 6. Intramural (aortic wall) infiltration. Needle tip partially in aortic wall. Minimal amount of medium has infiltrated the aortic wall. No sequelae.

iosus. Employing an 18-gauge needle, on the fifth pass we entered a vascular structure thought to be the pulmonary artery and injected 12 c.c. of 90 per cent Hypaque, in an attempt to demonstrate evidence of patent ductus with right-to-left shunt. The films showed the opaque material to have been injected into the outflow tract of the right ventricle, with approximately 3.0 c.c. infiltrating the myocardium. The electrocardiogram revealed evidence of a right bundle branch block, with reversion to a normal tracing the following day. The inadvertent right ventricular and intramyocardial injection produced no sequelae other than the electrocardiographic change.

Three times a small amount of radiopaque medium was injected into the aortic wall. In no instance was the intramural injection estimated to be more than 1.0 to 2.0 c.c. As shown on the films, the needle tip in each patient was against the aortic wall and presumably had partially penetrated the intima (Fig. 6). In every case, film study obtained within fifteen minutes after injection showed that the opaque substance had apparently been absorbed. These intramural minimal injections produced no complications.

Previous reference has been made to the 2 cases of unintentional injection into the pulmonary arterial system. No sequelae developed from these inadvertent injections.

In the latter portion of our total series, we established the practice of obtaining a film study of the entire chest, with the patient supine, immediately before the procedure and another of the same type fifteen minutes after completion of the examination. On the post-procedure films, an increase in the width of the superior mediastinal shadow was observed on 3 occasions, one of which is shown in Figure 7. We considered this to be evidence of bleeding into the superior mediastinum. The patients were followed carefully, and the mediastinal broadening was noted to regress, without treatment, within several days in each case. Two other film studies, obtained within forty-eight hours after procedure, also showed apparent slight broadening of the superior mediastinum. Here again no treatment was required. We suspect that such intramediastinal bleeding is of greater frequency than indicated by these 5 cases. Unfortunately, we did not adopt the routine of pre- and fifteen-minute post-procedure filming until late in our series. It is highly probable that such bleeding may, on occasion, be venous in origin, since it is not unlikely that needle entry into an innominate vein occurs with some frequency. Our experience thus far has been fortunate in that mediastinal bleeding has not produced any apparent serious complication. We are, however, aware of its potential seriousness.

In our experience there has been no occurrence of pericardial tamponade and no known instance of injury to the aortic valve or to a coronary artery. The procedure has not, to our knowledge, precipitated a coronary occlusion or myocardial infarction, although on 4 occasions the patient complained of angina-like pain

Fig. 7. Post-procedure widening of superior mediastinum.

A. Film obtained with patient supine, immediately before suprasternal thoracic aortography.

B. Successful suprasternal thoracic aortography.

C. Film fifteen minutes after injection procedure. Identical with A. Note superior mediastinal widening, evidence of intra-mediastinal bleeding.

similar in nature to previous anginal episodes.

Of the total patients, including those in whom no intra-aortic injection was effected, 46 had some type of intrapericardial cardiac surgery at some time after the procedure. The time interval between needle puncture procedure and surgery ranged from one to thirty days, except for one interval of one hundred and fifteen days. Of the 46 patients, 29 had surgery for aortic valvular disease; 11 had a Vineberg procedure; 2 had a coronary endarterectomy, and 4 had mitral valvular surgery. At surgical exposure of the heart and, to varying extent, the superior mediastinum, ecchymosis of the anterior mediastinal tissues was noted in 4 patients.

There were surgical notations of bloody fluid within the pericardium in 5 patients, the largest amount being estimated as 250 c.c. In no instance was there notation of appreciable clot formation within the pericardial sac.

Quality of Examinations: Among the 110 attempts at suprasternal thoracic aortography, there were 32 failures to consummate aortic injection and obtain satisfactory films. In 26 of these, as previously noted, no radiopaque medium was injected, because of failure to effect aortic

TABLE II: AORTIC INSUFFICIENCY STUDIES

Attempted Examinations	68
Failures	15
No aortic puncture—no injection	12
Equipment failure	2
Inadvertent pulmonary artery injection	1

OPACIFICATIONS (53 EXAMINATIONS)

	Ascending Aorta	Quality of Examination
Excellent	25	16
Good	10	16
Fair	11	11
Poor	7	10

TABLE III: CORONARY STUDIES

Attempted Examinations	38
Failures	15
No aortic puncture—no injection	13
Equipment failure	1
Inadvertent pulmonary artery injection	1

OPACIFICATIONS (23 EXAMINATIONS)

	Ascending Aorta	Coronary Artery Right	Coronary Artery Left
Excellent	20	4	1
Good	1	3	6
Fair	2	4	11
Poor	...	3	3
Failure	...	9	2

TABLE IV: PATENT DUCTUS ARTERIOSUS STUDIES

Attempted Examinations	4
Failures	2
No aortic puncture—no injection	1
Inadvertent right ventricular injection	1

OPACIFICATIONS (2 EXAMINATIONS)

	Ascending Aorta	Quality of Examination
Excellent	2	2

needle penetration, while in 2 there was unintentional injection into the pulmonary arterial system. In 3 examinations aortic injection was made but mechanical difficulty with the filming apparatus prevented our obtaining satisfactory films. The other failure consisted of right ventricular injection in the three-year-old child.

In evaluating the 78 studies in which aortic injection and filming were accomplished, we have graded each examination as to its effectiveness in accomplishing the purpose for which it was performed. When the procedure was employed for the principal purpose of establishing the presence and degree, or absence, of aortic valvular insufficiency, the grading was adjudged on the basis of whether there were sufficient volume and concentration of the radiopaque medium at the level of the aortic valve to demonstrate regurgitant reflux through that structure if valvular insufficiency existed.

When the primary purpose was evaluation of the status of the coronary arterial system, the studies were graded on the basis of whether appearances suggested that the coronary ostia had been exposed to enough of the radiopaque agent to permit coronary filling, and also on the basis of opacification and clarity of demonstration of the coronary arteries.

Grading of coronary opacification is admittedly rather difficult. In our evaluation of coronary arteriography, we have given consideration to the main trunk of the *right* coronary artery throughout its course; for the *left* coronary artery, we have assessed the short main trunk and its two major branches (anterior descending and circumflex). Gradings have been based on the coronary visualizations obtained without (in this communication) regard for the fact that *non*-visualization of a coronary artery may be due to stenotic or obstructive coronary disease. Designations of "excellent," "good," "fair," "poor," or "failure" have been applied to each examination. The degree of opacification of the entire ascending aorta, including the aortic sinuses, has been so graded, as has each examination on the basis of the over-all quality of the study. Tables II, III, and IV summarize the results of all examinations.

What we consider to be a satisfactory position of the needle, excellent aortic opacification, clear demonstration of the aortic valve cusps, and satisfactory visualization of the coronary arteries is illustrated in Figure 8. It should be noted that there is no evidence of any regurgitant opacification of the left ventricle, and the aortic valve presents a normal appearance.

Figure 9 illustrates essentially normal appearances of aortic valves, but somewhat

Fig. 8. Suprasternal thoracic aortography. Excellent opacification of thoracic aorta, aortic sinuses, and coronary arteries. A. First of serial films, immediately before injection. B. Beginning injection of 35 c.c. of 85 per cent opaque medium. C. Completion of two-second injection. D. One and one-half seconds after completion of injection.

less satisfactory coronary artery visualization.

A deformed aortic valve with thickening and distortion of the cusps is shown in Figure 10. In this case, there is slight regurgitant opacification of the left ventricle, indicating some element of aortic valvular insufficiency. There is some blurring of the right coronary artery as a result of motion.

In Figure 11, the position of the needle tip is not ideal in that it approximates the right aortic wall and is a little higher than desired. Aortic valve deformity and moderate regurgitant opacification of the left ventricle are noted. In spite of the

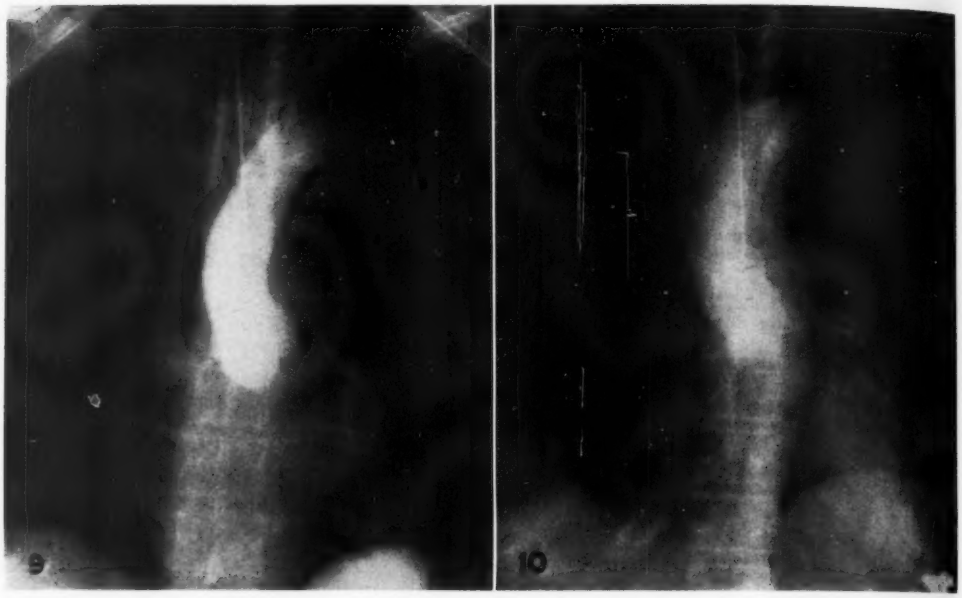

Fig. 9. Suprasternal thoracic aortography. Excellent opacification of ascending aorta (normal appearance). No regurgitant opacification of left ventricle. Somewhat less satisfactory coronary visualization.
Fig. 10. Suprasternal thoracic aortography. Deformed aortic valve, with thickening and distortion of valve cusps. Slight regurgitant opacification of left ventricle, evidence of slight aortic valvular insufficiency.

somewhat high position of the needle tip and the aortic insufficiency, satisfactory opacification of both coronary arteries is accomplished.

Incomplete filling of both right and left coronary arteries is evident in Figure 12. Areas of irregular filling of the lumen are noted in the anterior descending branch of the left coronary artery, along with apparent marked narrowing of the circumflex branch. The opinion of extensive coronary arterial disease was confirmed at subsequent surgery (Vineberg procedure).

An area of segmental marked narrowing of the anterior descending branch of the left coronary artery is demonstrated in Figure 13. This also was confirmed as a localized atherosclerotic process on a subsequent attempt at coronary endarterectomy plus a Vineberg procedure. In this case, the needle tip engages the right aortic wall and there is minimal aortic wall infiltration with the radiopaque medium.

Thickened aortic valve cusps are demonstrated in Figure 14. In this case, a minimal regurgitant puff of radiopaque medium is seen in the left ventricle. The ascending aorta is dilated, as is usual in aortic valvular disease. Clinically, the aortic lesion was predominantly one of aortic stenosis.

Figure 15 illustrates a marked regurgitant opacification of the left ventricle. In our grading system, we would classify this as a 4 plus aortic insufficiency (grading basis 0 to 4). At open heart surgery for correction of the insufficiency, the findings were those of severe insufficiency of the aortic valve.

Contraindications to Suprasternal Thoracic Aortography: Additional experience will very likely define more fully the indications and contraindications for our present procedure of suprasternal thoracic aortography. At the present time, we list the following as contraindications: bleeding tendencies and blood dyscrasias; patients under anticoagulant therapy; disease affecting the cervical spine to a degree to prevent satisfactory hyperextension of the head and neck for unobstructed

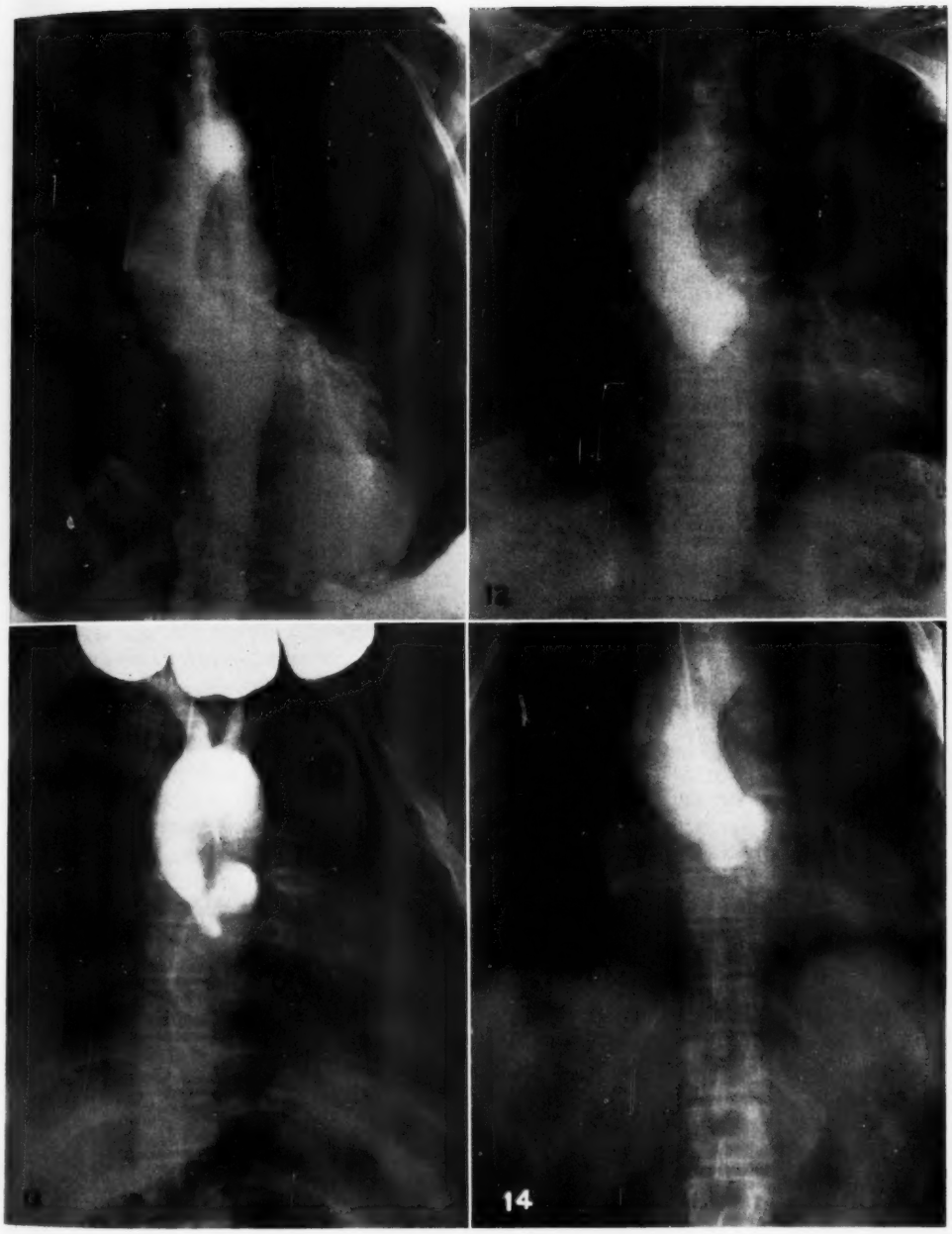

Fig. 11. Suprasternal thoracic aortography. Needle tip approximates right aortic wall and is higher than desired. Marked aortic valve deformity. Regurgitant opacification of left ventricle. Good coronary visualization.

Fig. 12. Suprasternal thoracic aortography. Incomplete filling of both coronary arteries. Irregular lumen defects in anterior descending branch of left coronary artery. Narrowing of circumflex branch. Confirmation of extensive coronary disease at surgery (Vineberg procedure).

Fig. 13. Suprasternal thoracic aortography. Segmental filling defect in anterior descending branch of left coronary artery. Confirmed as localized atherosclerotic process at subsequent surgery. Note minimal intramural infiltration.

Fig. 14. Suprasternal thoracic aortography. Thickened aortic valve cusps. Minimal regurgitant puff of opaque material into left ventricle. Clinically predominant aortic stenosis.

Fig. 15. Suprasternal thoracic aortography. Marked regurgitant opacification of left ventricle, classified as four plus aortic insufficiency. Confirmed at open heart surgery.

suprasternal needle insertion; aneurysm in the arch or ascending portion of the aorta; certain tumors of the neck and mediastinum; anatomical deformities of the thorax sufficient to distort the anatomical relationships of the ascending aorta; certain cardiac arrhythmias, *i.e.*, atrial fibrillation with a poorly controlled ventricular rate; supraventricular tachycardia of vagal origin or resulting from atropinization; ventricular tachycardia; very frequent ventricular premature beats.

DISCUSSION

The ultimate place and value of this procedure of suprasternal thoracic aortography are, we believe, yet to be determined. In our opinion it is another method of direct delivery of radiopaque medium to the ascending aorta and, as such, can effect excellent opacification of the thoracic aorta and its branches. The direct demonstration of regurgitant reflux from the aorta into the left ventricle can be achieved and such demonstration, under the conditions of the procedure as we employ it, is, as we interpret it, evidence of dynamic aortic valvular insufficiency. It appears that some estimation or quantitation of aortic insufficiency is also possible by the procedure. By its application to coronary artery opacification, rather satisfactory demonstration of the coronary system can, on occasion, be obtained.

The procedure is not without very real hazard. The potential dangers of needle trauma-tear of the aortic wall or other mediastinal vascular structures, intramediastinal or intrapericardial hemorrhage, laceration of a coronary artery or aortic valve cusp, aortic intramural or para-aortic injection of radiopaque medium, and pneumothorax must be considered.

We have attempted the procedure in only one child, three years of age. Considering the small size of the aorta in infants and children, it is our present feeling that the procedure presents too much risk and its accomplishment is too difficult to adapt it to such patients.

It is suggested that emphasis be placed upon the following factors to obviate possible complications:

1. Careful study of preliminary chest films to determine as accurately as possible the direction of needle insertion and the maximal permissible distance of the needle advancement.

2. Scrupulous attention to the pressure wave recordings, and withholding of radiopaque injection if there is any suggestion of pressure wave "damping."

3. Avoidance of any voluntary or involuntary movement of the patient, especially the head and neck, during or after intramediastinal insertion of the needle.

4. Strict attention to the prevention of any further movement of the needle other than that transmitted by the aortic pulsations, once the needle has been satisfactorily positioned.

5. Conservatism regarding repeated needle passes. It is our recommendation that no more than four needle passes be

permitted to obtain satisfactory intra-aortic positioning of the needle.

6. Discontinuance of the procedure at the earliest sign of any aberration in patient reaction, persistent electrocardiographic changes, or technical difficulties as indicated above.

SUMMARY

A transthoracic needle puncture procedure for opacification of the ascending aorta, by way of a suprasternal approach, is described. The application of this procedure to the demonstration of certain pathological states of the thoracic aorta and the aortic valve is discussed. Reference is also made to use of the procedure for coronary arterial opacification.

Technical details of roentgen filming, aortic needle puncture, pressure and electrocardiographic monitoring, and opaque medium injection are presented.

Electrocardiographic changes incident to the procedure are described.

Reactions and complications are enumerated.

Recommendations for minimizing the hazards of the procedure are suggested.

Possible contraindications to the procedure are considered.

An analysis of the authors' experience with 110 suprasternal thoracic aortographies in 93 patients, with tabulation of the results obtained, is presented.

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ADDENDUM

Since submission of this paper for publication, an additional 53 suprasternal thoracic aortographies have been undertaken Included in these additional studies has been one fatality directly attributable to the procedure. This fatality occurred in a 31-year-old female, who presented clinical evidence of congenital heart disease with superimposed aortic valvulitis.

As part of the diagnostic work-up, a suprasternal thoracic aortography was performed. Satisfactory needle puncture of the ascending aorta was achieved on the fourth needle pass, and undamped pressure waves were recorded (100/15 mm. Hg). Twenty cubic centimeters of 85 per cent Hypaque were injected in 1.5 seconds, and the needle was immediately withdrawn. Directly following the injection, the patient experienced the usual momentary sensation of generalized heat, followed by moderate headache and some substernal distress, lasting for approximately five minutes. She was returned to her room in good condition twenty minutes after completion of the procedure.

The film studies revealed slight dilatation of the ascending aorta and an approximate 3 plus regurgitant opacification of the left ventricle, which was considerably enlarged. There was no opacification of the right ventricle or the pulmonary artery. The needle tip was positioned 4.0 cm. above the level of the aortic valve, and engaged the right aortic wall. There was minimal (estimated 1.0 to 2.0 c.c.) intramural infiltration of the radiopaque medium into the right aortic wall.

Approximately twenty five minutes after her return to her room, the patient showed signs of cardiac tamponade, with a fall of systolic blood pressure to 70 mm. Hg. Transthoracic pericardial needle puncture was performed and 200 c.c. of blood obtained. The systemic systolic pressure rose to 100 mm. Hg. Twenty minutes later (approximately two hours post-aortography) the patient had a sudden onset of syncope and slight convulsive movements, and the blood pressure dropped to zero. An endotracheal tube was inserted

and the left chest was immediately opened. The pericardial sac was found to be tensely distended with the heart in standstill. Pericardiotomy yielded 500 c.c. of blood. Forceful cardiac action was spontaneously resumed, and the patient promptly returned to consciousness. Drains were placed in the pericardial sac and the pleural space; the chest wall was closed and the patient placed on whole blood transfusions.

During the next fourteen hours, approximately three liters of blood were obtained through the drainage tubes, and it was considered necessary to re-open the chest. Extensive exploration failed to demonstrate any single major source of the bleeding. There were several small areas of slow bleeding along the cut edges of the pericardium, which were easily controlled.

With the pericardial sac reasonably dry, the chest wall was again closed, with drainage. Ten minutes after chest closure, a tachycardia of 160 developed, while a systolic blood pressure of 140 mm. Hg was maintained. Approximately twenty minutes later, sudden cardiac arrest occurred. Immediate re-opening of the chest revealed cardiac standstill, which reverted to ventricular fibrillation on cardiac massage. Defibrillation efforts, along with the usual pharmacological agents, failed to effect return of adequate cardiac contraction, and irreversible cardiac arrest ensued.

Autopsy revealed a moderate-size membranous interventricular septal defect and severe aortic valvulitis. Located 1.5 cm. above the non-coronary aortic valve cusp, was a 0.5-mm. needle puncture surrounded by hemorrhagic thickening of the adventitia.

This is our single fatality in a total series of 163 suprasternal thoracic aortography studies. Death was unquestionably caused by aortic bleeding, even though the point of bleeding could not be demonstrated at thoracotomy.

We are convinced that such bleeding, particularly as it may occur below the upper margin of the pericardial reflection onto the ascending aorta is the major hazard of suprasternal thoracic aortography. We believe it is of sufficient moment to invalidate any "routine" employment of the suprasternal technic for aortography or coronary arteriography. It would appear that the procedure should, at best, be limited to selected cases and only to those with a prominent ascending aorta which is in comparatively close relationship to the suprasternal notch, sufficiently so to permit of relatively easy needle introduction into the ascending aorta above the level of the pericardial reflection.

It is our present position that we much prefer a catheter thoracic aortography type of procedure to suprasternal thoracic aortography as described in this article.

SUMMARIO IN INTERLINGUA

Aortographia Thoracic Suprasternal (Opacification del Aorta Thoracic per Acupunctura Transthoracic Suprasternal)

Es describite un methodo de acupunctura transthoracic pro le opacification del aorta ascendente via le accesso suprasternal. Cento dece essayos de effectuar le opacification aortic per medio de iste technica esseva interprendite in 93 patientes.

Le resultatos del examines in que le injection aortic e le production de radiogrammas esseva completate, esseva classificate como excellente, bon, satis bon, e pauco bon. Super le base del qualitate general del studios, 16 esseva classificate como excellente, 16 como bon, 11 como satis bon, e 10 como pauco bon. Le demonstration del aorta ascendente esseva excellente in 25 casos, bon in 10, satis bon in 11, e pauco bon in 7.

Le mesme technica esseva usate pro le visualisation del arteria coronari. Un reporto preliminari del resultatos es includite. Un certe grado de opacification del coronario dextere o sinistre o de ambes esseva effectuate in 23 de 38 casos.

In 2 casos un patente ducto arteriose esseva demonstrate.

In quasi omne le casos il occurreva un certe reaction immediate al injection, sed complicationes importante occurreva in solmente 7. In omne iste casos le restablimento esseva prompte. Tamen, le technica non es disproviste de periculo. Contraindicationes es listate. Le interruption del examine es indicate si tosto que le prime tracia de un aberration es notate in le reaction del patiente o quando persistente alterationes electrocardiographic deveni manifeste.

(*For Discussion of this paper, see page 48*)

Radiological Evaluation of Isolated Ventricular Septal Defects Before and After Surgical Closure[1]

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THE REMARKABLE and often spectacular accomplishments in the field of cardiac surgery are familiar to each of us who has been in a position to follow the radiographic course of these patients. Whereas a short time ago only those radiologists associated with large teaching hospitals had this opportunity, many institutions now have their own "cardiac team" and are successfully diagnosing and correcting surgical defects of the heart. Consequently whether we are associated with a large teaching institution or a smaller hospital, or are even following the postoperative cardiac patient in office practice, it behooves us as radiologists to be familiar with the radiologic aspects of congenital heart disease and the changes to be expected following surgery.

With the development and improvement of the pump-oxygenator, the surgical correction of many forms of congenital heart disease has become a common procedure. Although an isolated ventricular septal defect reportedly represents only about 8 per cent of all forms of congenital heart disease (1), in our series it was the most common defect for which open heart surgery was performed (2). At the time of this writing, approximately 150 ventricular septal defect closures have been performed at The Texas Children's Hospital. Each of these surgical procedures was done by Dr. Denton Cooley and his associates. Because of the accumulation of this number of cases, and because there is little reported information concerning the radiologic aspects following surgery, the present evaluation seems appropriate.

Isolated ventricular septal defects are usually considered to be of two general types (3): the "simple" defect which occurs in the lower portion of the ventricular septum and the more disabling defect located at a higher level, near the aortic root. Regardless of the location of the defect, the clinical course and the radiographic findings depend more on its size than on its position. In the present study consideration is given only to the ventricular septal defects unassociated with other cardiac abnormalities.

Preceding the preparation of this paper, a review of a large number of patients with isolated ventricular septal defects led to the clinical impression that there were distinct variations within the group of patients with this malformation (4). It further appeared that the heart size, the symptomatology, and the response to surgery varied with the degree of pulmonary hypertension and the magnitude and direction of the intracardiac shunt. An effort was made to assess the accuracy of this clinical impression by considering all the patients with isolated ventricular septal defects for whom complete physiologic studies (5) were available. For many of the patients who had presurgical evaluation elsewhere catheterization data were incomplete, and the series was thus narrowed from approximately 300 to 144.

The patients were placed in groups which were based arbitrarily on the ratio of the systolic pulmonary artery pressure to the systolic systemic pressure and the magnitude and direction of the shunt through the ventricular defect (Fig. 1). All patients in whom the pulmonary systolic

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[1] From the Departments of Radiology and Cardiology, Texas Children's Hospital, and from the Department of Surgery, Baylor University College of Medicine. Presented as part of a Symposium on Cardiovascular Roentgen Diagnosis at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958.

The catheterization data used in this study were provided by Joseph R. Latson, M.D., Director of the Catheterization Laboratory, Texas Children's Hospital.

pressure was less than 50 per cent of the systemic pressure were designated as Group I, while patients in whom the systolic pulmonary pressure was between 50 and 85 per cent of the systemic pressure constituted Group II, both of these groups having only a left-to-right shunt. The remainder of the patients, *i.e.*, those in whom the pulmonary systolic pressure was approximately equal to the systemic pressure, were divided according to the volume and direction of the shunt. In Group III there was a large left-to-right shunt; Group IV had an essentially balanced shunt with very little flow in either direction across the ventricular defect; Group V had only a right-to-left shunt at the ventricular level. This classification is similar in many respects to that devised by Kjellberg (6), the difference being in the number of groups and method of division.

CLASSIFICATION OF INTERVENTRICULAR SEPTAL DEFECT

	RATIO OF PULMONARY SYSTOLIC PRESSURE TO SYSTEMIC SYSTOLIC PRESSURE	DIRECTION AND MAGNITUDE OF SHUNT
GROUP I	PULMONARY SYSTOLIC LESS THAN 0.50 SYSTEMIC	L→R SHUNT ONLY
GROUP II	PULMONARY SYSTOLIC 0.50 TO 0.85 SYSTEMIC SYSTOLIC	L→R SHUNT ONLY
GROUP III	PULMONARY SYSTOLIC 0.85 TO GREATER THAN SYSTEMIC	LARGE L→R SHUNT WHILE BREATHING 100% O_2 OR AIR ± SMALL R→L SHUNT
GROUP IV		SMALL TO NO L→R WHILE BREATHING AIR MODERATE L→R WHILE BREATHING 100% O_2 ± R→L SHUNT
GROUP V		R→L SHUNT ONLY

Fig. 1. Classification of isolated ventricular septal defects.

After the patients had been classified, the electrocardiograms and the cardiac size and configuration, as determined radiologically, were evaluated in each group. The electrocardiograms were seen to change from predominant left ventricular hypertrophy in Group I to combined ventricular hypertrophy in Group III and to right ventricular hypertrophy in Group V.

RADIOGRAPHIC EVALUATION

The radiographic study consisted in an estimation of heart size, based on the cardiothoracic ratio, evaluation of right and left ventricular enlargement and left atrial enlargement, determination of size of the undivided pulmonary artery segment, and an estimate of pulmonary vascularity. Although it is recognized that the cardiothoracic ratio is not an entirely accurate measure of heart size, it was the most practical method of comparing this group of patients with the surgical group. In order to have an associated index of heart enlargement, especially for the infant age group, in which the cardiothoracic ratio is normally greater than the older child (7), an evaluation of size by estimate was made, 0 being normal and 1+ to 4+ indicating degrees of cardiac enlargement. The use of a planimeter to measure cardiac area was impractical because of the indefinite boundary of the cardiac silhouette in many of the infants, in whom an overlying thymus prohibited accurate determination.

Right and left ventricular size was assessed from oblique views by the commonly accepted roentgen criteria. No attempt was made, however, to grade the size of the chambers, estimation only being made as to

whether or not they were of normal size (N) or enlarged (↑). Similar evaluation was made of the size of the left atrium, as determined by esophageal displacement in radiographs obtained with the patient in the right anterior oblique position.

The convexity of the undivided pulmonary artery segment in postero-anterior radiographs was graded in terms of pluses, + to +++, representing magnitudes of enlargement. Pulmonary vascularity

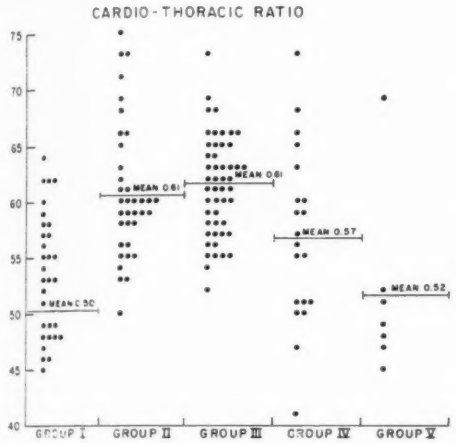

Fig. 2. Cardiothoracic ratio in 144 cases of isolated ventricular septal defects.

was evaluated in terms of increased, normal, or decreased markings.

The results of these radiological determinations follow.

Cardiothoracic Ratio: In Group I, numbering 31 cases, the mean cardiothoracic ratio was 0.5, with a standard deviation of 0.04 and a standard error of 0.01. Evaluation of heart size in plus magnitudes was 0.81+ (Fig. 2).

In Groups II and III (86 patients) there was no significant difference in heart size, the mean cardiothoracic ratio in each case being 0.61. In Group II the standard deviation was 0.03 with a standard error of 0.01, and in Group III the standard deviation was 0.04, also with a standard error of 0.01. Consequently in further discussion these two groups will be considered together. Estimation of heart size in terms

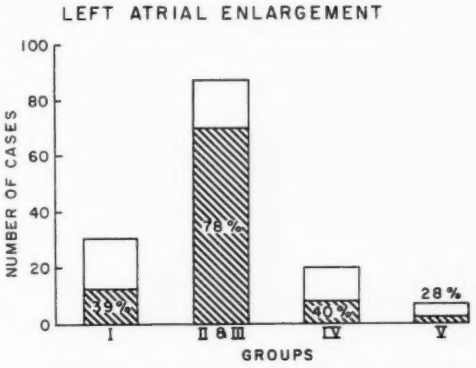

Fig. 3. Distribution of left atrial enlargement (shaded areas) in 144 cases of isolated ventricular septal defects.

of pluses was 2.2+ with a range of 0 to 4+.

In Group IV the mean cardiothoracic ratio of 20 patients was 0.57, with a standard deviation of 0.08 and a standard error of 0.02. Estimation of heart size in terms of pluses showed a mean of 1.25+ with a range of 0 to 4+.

There were only 7 patients in Group V, the cardiothoracic ratio being 0.52, with a standard deviation of 0.08 and a standard error of 0.03. Estimation of enlargement in terms of pluses showed a mean of 0.86+ and a range of 0 to 3.

Ventricular Enlargement: The estimation of right and left ventricular size was made from oblique views by the commonly accepted roentgen criteria, but it was soon obvious that the electrocardiogram was more reliable and more suitably correlated with the physiologic data obtained at catheterization. In Groups I and V there was reasonable accuracy in the correlation of radiographic interpretation of ventricular size with electrocardiographic data. In Groups II and III, however, as well as Group IV, in which there were varying degrees of combined hypertrophy noted electrocardiographically, there was no consistent correlation. Consequently radiologic evaluation of ventricular enlargement was not considered valid in the grouping of patients and the results of these studies are not included.

Left Atrium: Left atrial enlargement was determined by the presence of esophageal

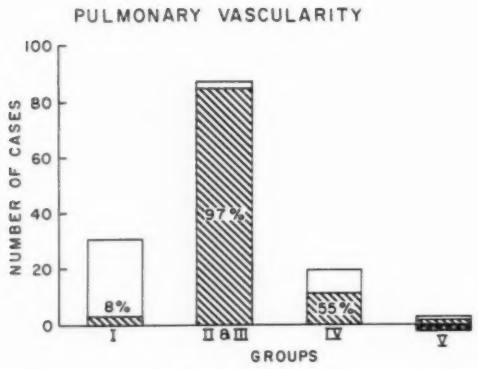

Fig. 4. Distribution of increased (shaded areas), decreased (black area), and normal (clear areas) pulmonary vascularity of 144 cases of isolated ventricular septal defects.

displacement from radiographs made with the patient in the right anterior oblique position, and with contrast material in the esophagus. Because of the factitious enlargement of the left atrium often seen in expiratory films, only those cases with suitable inspiratory radiographs were included.

Of the Group I patients, 39 per cent showed definite evidence of left atrial enlargement (Fig. 3). In these cases the extent of the enlargement could not be measured accurately, but the overall impression was that it was slight to moderate.

In Groups II and III the percentages were not significantly different and consequently were combined, giving an average of 78 per cent showing left atrial enlargement. The degree of enlargement was greater than noted in Group I.

In Group IV the number of cases with left atrial enlargement dropped to 40 per cent, and in Group V to 28 per cent.

Pulmonary Artery: Estimation of the size of the undivided portion of pulmonary artery was difficult because of the variability of the normal convexity of that structure in children. An estimation of abnormal prominence was therefore purely empirical; and evaluation was in terms of 0 as normal and pluses ranging up to 3+ denoting the degree of abnormal convexity.

In Group I the average estimation was 0.5+. This rose to 1+ in Group II and 1.5+ in Group III. Again, because of the similarity in these two groups, they have been combined, thereby giving a pulmonary artery convexity of 1.3+. The size of the pulmonary artery in Group IV was 2+ and in Group V 3+.

Pulmonary Vascularity: Pulmonary vascularity was in many instances very difficult to evaluate because of the normal variability. An attempt was made, however, without knowledge of the pulmonary pressure beforehand, to determine whether the vascular markings were increased, normal, or decreased in prominence (Fig. 4).

GROUPS	CARDIAC ENLARGEMENT	PULMONARY VASCULAR MARKINGS	LEFT ATRIAL ENLARGEMENT	PULMONARY ARTERY SEGMENT
I	0	0 to ↓	0	0 to +
II & III	++ to +++	↑	+	+ to +++
IV	+	↑	±	++ to +++
V	0	0 to ↓	0	++ to +++

Fig. 5. General summary of pertinent radiographic features in isolated ventricular septal defects.

Of Group I, only 8 per cent were considered to have increased pulmonary vascularity, the remainder being normal.

Ninety-one per cent of the patients in Group II and 100 per cent in Group III had increased vascular markings and once again, because of the overall similarity of these two groups, they were combined, giving an average estimation of 97 per cent showing increased vascularity.

In Group IV, only a little over one-half, (55 per cent) were considered to have abnormally prominent pulmonary vascular markings, and in Group V this figure dropped to 20 per cent. Thirty per cent of this latter group were thought to have a normal vascular pattern and 50 per cent showed definitely decreased markings.

These results demonstrate, in substance, that there is a definite radiologic correlation between heart size, left atrial enlargement, pulmonary artery convexity, pulmonary vascularity, and the direction and size of the interventricular shunt and the pulmo-

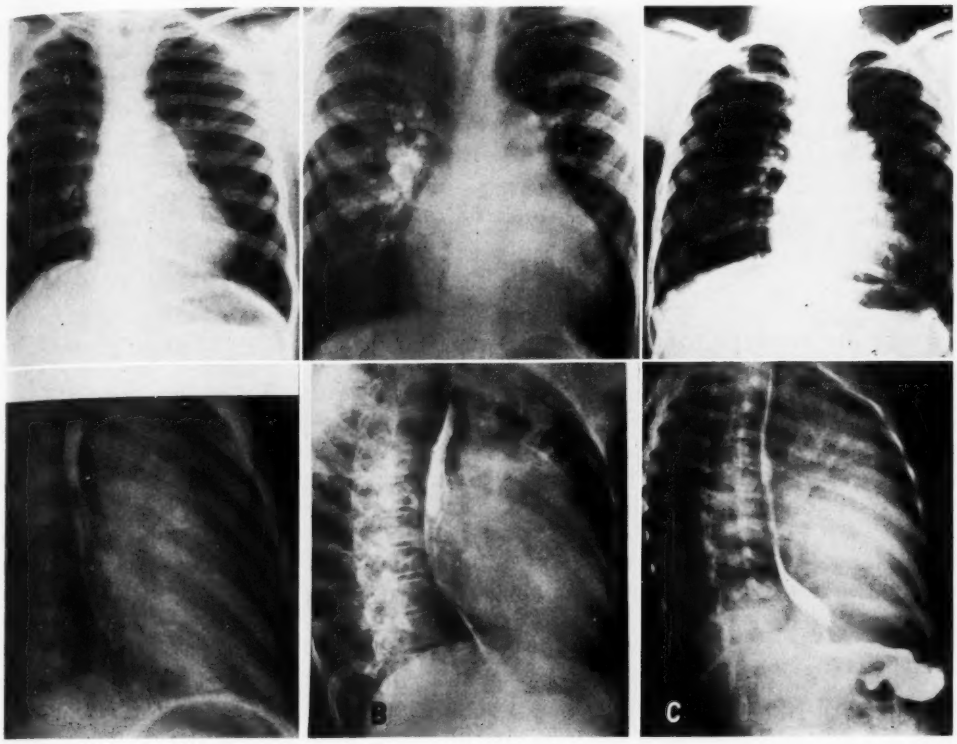

Fig. 6. Three cases of isolated ventricular septal defects.
A. Small left-to-right shunt (Group I) with essentially normal systolic pulmonary-systemic artery pressure. Heart is of normal size and left atrium is not enlarged. Pulmonary vascularity is not definitely increased.
B. Large left-to-right shunt with pulmonary artery pressure approximating that of the systemic pressure. Heart is large, with associated increased prominence of pulmonary artery segment and increased pulmonary vascularity. Left atrium is also definitely enlarged.
C. With right-to-left shunt (Group V) the heart is of normal size and left atrium is not enlarged. Peripheral pulmonary vascular markings are normal or decreased, but undivided pulmonary artery segment is prominent.

nary artery pressure. There are certain inconsistencies in this relationship but in the majority of instances the radiologic criteria are valid. This is demonstrated in Figure 5, which shows these characteristics. In Group I the heart is usually of normal size, pulmonary vascular markings are only slightly increased, the left atrium is normal or slightly enlarged, and the pulmonary artery segment of normal or slightly increased prominence. In combined Groups II and III the heart is usually moderately enlarged and pulmonary vascularity considerably increased, with an abnormally prominent pulmonary artery segment. The left atrium in this group of cases is also definitely enlarged. In Group IV the heart is enlarged but smaller than in Groups II and III, the pulmonary artery segment is approximately the same as in the above two groups, and the left atrium may or may not be enlarged. In Group V the heart is usually small and the pulmonary artery segment very prominent. Pulmonary vascularity in this group is usually diminished or, at best, normal in appearance, and the left atrium is seldom enlarged (Fig. 6).

POSTOPERATIVE RESULTS

In this group of 144 patients with isolated ventricular septal defect, operative closure was performed in 133. The youngest patient was six weeks of age and the oldest seventeen years. Separate evaluation of the preoperative chest roentgenograms in respect to cardiothoracic ratio, heart

size, size of left atrium, size of the pulmonary artery, and prominence of the pulmonary vasculature, in the manner described above, provided statistics essentially the same as were found in the overall study. Postoperative studies with reference to these same factors were made immediately after operation, two to six months after operation, at six months to one year and one to two years, and after two years.

Fifteen of these patients were of the Group I type, 85 were in the combined Groups II and III, 9 in Group IV, and 4 in Group V. Mortality figures were 0 in Group I, 19 per cent in combined Groups II and III, 22 per cent in Group IV, and 0 in Group V.

Radiographic examination in the immediate postoperative period was made in all patients who survived the surgical procedure but, because many of the patients were referred from distant communities, additional follow-up studies were not possible in all. Consequently the number of postoperative examinations became increasingly fewer over the periods designated for evaluation. Because the changes were essentially the same for all groups, except for differences in the pulmonary vascularity in Groups IV and V, the data showing changes in the heart size and pulmonary artery are grouped together. The results of these determinations follow.

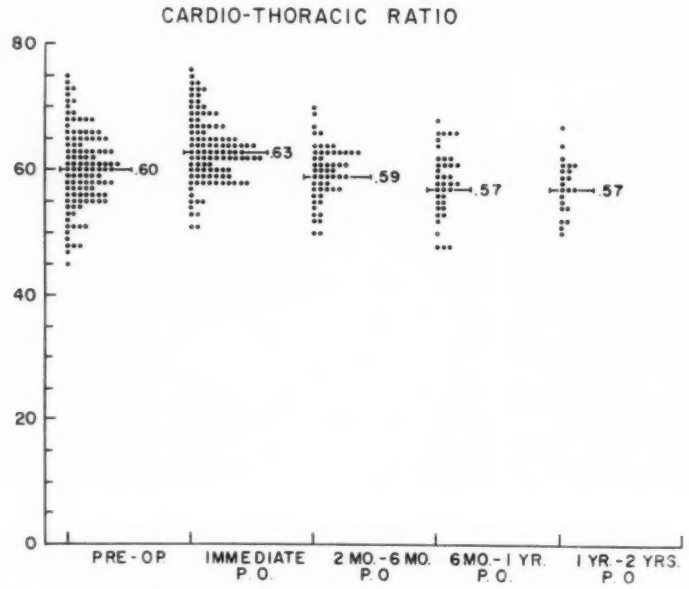

Fig. 7. Cardiothoracic ratio of isolated ventricular septal defects before and after surgical repair.

Cardiothoracic Ratio

Preoperative: The mean preoperative cardiothoracic ratio of 128 patients, including all groups, was 0.60, with a standard deviation of 0.06 and a standard error of 0.006 (Fig. 7).

Immediate Postoperative: Cardiac measurements and evaluation of the pulmonary vascularity were made from upright roentgenograms obtained when the patient was well enough to be transferred to the X-Ray Department. The routine postoperative portable films were unsatisfactory for evaluation because of the distortion produced by the short tube-film distance and the semirecumbent position of the patient. The time interval varied from five days to two weeks. The mean cardiothoracic ratio

in this period of time in 107 patients was 0.63, with a standard deviation of 0.05 and a standard error of 0.005. This is an increase of 3 per cent over the mean preoperative measurement. One hundred per cent of the Group I patients showed an increase in heart size in the postoperative period; 24 of 32 patients (75 per cent) in Group II; 38 of 50 patients (76 per cent) in Group III; 7 of 9 (77 per cent) in Group IV; and 4 of 4 patients (100 per cent) in Group V.

Two to Six Months: The mean cardiothoracic ratio of 56 patients having chest roentgenograms during the two-to-six-month interval was 0.59, with a standard deviation of 0.05 and a standard error of 0.007. This represents an average decrease of nearly 1 per cent when compared with the preoperative cardiothoracic ratio. Four of 6 patients (66 per cent) in Group I, 4 of 17 (23 per cent) in Group II, 8 of 29 (27 per cent) in Group III, 2 of 2 (100 per cent) in Group IV, and 2 of 2 (100 per cent) in Group V showed cardiac enlargement greater than on preoperative examination.

Six Months to One Year: The mean cardiothoracic ratio of 42 patients examined between six months and a year after operation was 0.57, with a standard deviation of 0.10 and a standard error of 0.02. This is an average decrease in heart size of approximately 3 per cent of the preoperative size. Three of 6 patients (50 per cent) in Group I, 2 of 10 (20 per cent) in Group II, 8 of 21 (40 per cent) in Group III, 3 of 3 (100 per cent) in Group IV, and 1 of 2 (50 per cent) in Group V showed cardiac enlargement greater than had been measured before operation.

One to Two Years: The mean cardiothoracic ratio of 23 patients examined between one and two years postoperatively was also 0.57, with a standard deviation of 0.045 and a standard error of 0.01. This represents an average decrease in heart size of approximately 3 per cent. Two of 4 patients (50 per cent) in Group I, 1 of 6 (16 per cent) in Group II, 3 of 11 (27 per cent) in Group III, and 1 of 2 patients (50 per cent) in Group V showed cardiac enlargement greater than was measured preoperatively.

After Two Years: Only 2 patients had chest roentgenograms in our department two years after operation. The cardiothoracic ratio in one was 0.59 as compared to a preoperative measurement of 0.62 and in the other 0.51 as compared to a preoperative ratio of 0.63.

Pulmonary Artery

Preoperative: The preoperative estimation of the convexity of the pulmonary artery in 100 patients, including all groups, was 2.10+, with a standard deviation of 1.02 and a standard error of 0.09. Seventy per cent of the total number of patients had a prominent pulmonary artery segment.

Immediate Postoperative Period: During the immediate postoperative period, 54 of 102 patients (53 per cent) showed a decrease in convexity of the pulmonary segment. The remainder showed no change.

Two to Six Months: During the two-to-six-month interval 26 of 53 patients (49 per cent) showed a decrease in pulmonary artery prominence compared to the preoperative examination; in 4 patients (all in Group II) the artery was increased in size.

Six Months to One Year: Twenty-four of 41 patients (58 per cent) showed a decrease in size of the pulmonary artery between two and six months after operation. In 3 the artery had increased in size.

One Year to Two Years: Twenty patients (70 per cent) followed for one to two years showed a decrease in the size of the pulmonary artery as compared to the preoperative studies.

After Two Years: Only 2 patients were followed longer than two years, and both showed a smaller pulmonary artery than had been noted preoperatively.

Pulmonary Vascularity

Preoperative: In Group I, only 7 per cent of the patients were considered to have abnormally prominent pulmonary vascular markings; in the remainder the markings

were normal (Fig. 8). Ninety-five per cent of the combined Groups II and III showed increased markings; in the remaining 5 per cent the appearance was normal. In Group IV, 10 per cent had increased markings, and 9 per cent were considered to have a normal vascular pattern. In Group V, 25 per cent had markings which were considered abnormally prominent, 50 per cent decreased, and 25 per cent within normal limits.

the remainder appearing normal. Only one patient in Group IV was seen in this interval, and he exhibited an increase in pulmonary vascular pattern. Of the 2 patients in Group V, 1 had increased markings and the other normal vascularity.

Six Months to One Year: Fifty per cent of Group I patients showed increased pulmonary vascularity, 53 per cent of Group II and III showed an increase, the remainder appearing normal. No patients in

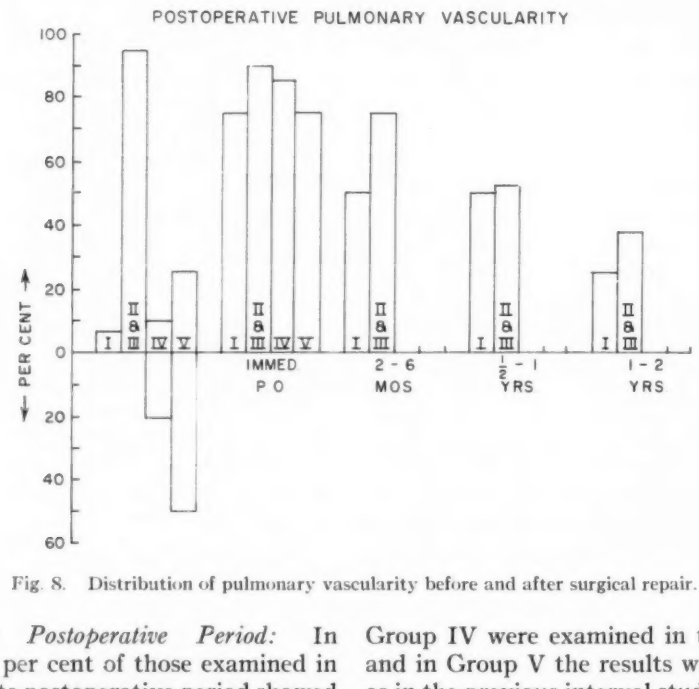

Fig. 8. Distribution of pulmonary vascularity before and after surgical repair.

Immediate Postoperative Period: In Group I, 75 per cent of those examined in the immediate postoperative period showed an increase in pulmonary vascularity, the rest appearing normal. Ninety per cent of Groups II and III showed increased markings. In Group IV, 85 per cent showed an increase in vascularity, with 12 per cent normal. In Group V, 75 per cent showed an increase in pulmonary vascular markings and 25 per cent showed a normal vascular pattern.

Two to Six Months: From two to six months, 50 per cent of those in Group I showed abnormally prominent vascular markings. In the combined Groups II and III, 75 per cent showed increased markings,

Group IV were examined in this interval, and in Group V the results were the same as in the previous interval study.

One to Two Years: In Group I, 25 per cent still had increased vascular markings between one and two years. In Group II, 50 per cent showed increased markings and in Group III only 27 per cent. The small number of cases considered, however, discredits the reliability of the discrepancy between Groups II and III. No patients in Group IV were seen in this interval and in the 1 patient in Group V vascularity was normal.

Two Years: The pulmonary vascularity was evaluated in only 2 patients after two years. One was in Group I and one in

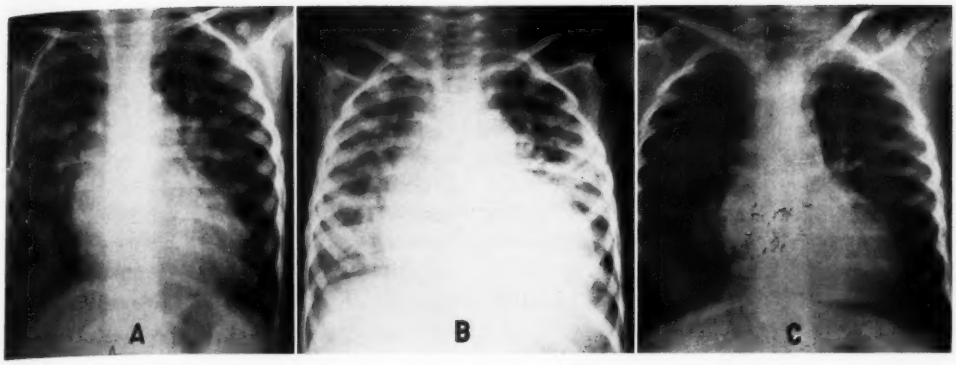

Fig. 9. Postoperative changes.
A. Preoperative chest roentgenogram showing Group III ventricular septal defect.
B. One week postoperatively the heart is larger and pulmonary vascularity increased, without evidence of cardiac decompensation.
C. One year after operation the heart has regressed in size and vascularity is normal.

Group III. Each had a normal pulmonary vascular pattern.

DISCUSSION

The wide variation in the clinical course of patients with isolated ventricular septal defect is reflected in the equally wide variation in the radiographic features of heart size or configuration and lung vascular pattern, but when these components of the roentgen picture are correlated with the physiologic data, they become more meaningful and characteristic. It is obvious that there is some overlap in the classification derived from this correlation, but by and large the division represents a practical approach to the consideration of patients with isolated ventricular septal defects.

The data presented indicate that with a normal pulmonary artery pressure and a small shunt the radiographic appearance of the heart and pulmonary vascularity are usually normal. The left atrium is seldom enlarged and, if there is evidence of ventricular enlargement, it is confined to the left chamber. With elevation of the pulmonary artery pressure beyond 50 per cent of the systemic, and with a large left-to-right shunt, the radiographic features become more pronounced. The left atrium is enlarged as a result of increased blood flowing to this chamber, and the pulmonary artery and pulmonary vascularity become more prominent, also as a result of the shunt from the left side of the heart into the right ventricle and pulmonary circulation. We feel that the degree of left atrial dilatation is a reliable index of the effective pulmonary blood flow. Left ventricular enlargement predominates, but a certain number of cases show combined ventricular hypertrophy. The aorta is small.

Those cases in which the pulmonary systolic pressure is approximately equal to the systemic pressure, but with a large left-to-right shunt, show an accentuation of the features mentioned in the previous group, and, in addition, exhibit a larger degree of right ventricular hypertrophy and dilatation. With approximately equilibrated pulmonary and systemic artery pressures and with a small left-to-right shunt or a moderate right-to-left shunt, the overall size of the heart is smaller, although right ventricular hypertrophy is greater and the left atrium is less prominent. Peripheral pulmonary markings are usually normal or perhaps slightly decreased, but the pulmonary artery segment and the right and left branches are often unusually prominent. In the group in which the shunt is entirely right to left, left atrial enlargement is unusual and pulmonary vascular markings are more often decreased in prominence. The pulmonary artery segment remains large, but the overall size of

the heart is frequently normal or even below normal. There is no explanation at this time for the difference in pulmonary resistance seen in cases in which the defects are of equal size and the pressures in the pulmonary artery and aorta are the same.

Postoperatively, the sequence of radiographic changes is essentially the same for all groups. Immediately following operation there is an increase in heart size (Fig. 9), which apparently is the result of cardiotomy rather than a specific change characteristic of the surgical correction. Similar cardiac dilatation is seen in all types of cardiac surgery and probably is representative of cardiac decompensation. The greatest enlargement was found in those cases (Groups I and V) in which the preoperative cardiothoracic ratio was essentially normal. Between two and six months following surgery a regression in heart size had begun in all groups, with Group II and III showing the most improvement. Between six months and a year this regression continued, again with the greatest improvement in those patients who preoperatively had the largest hearts. After one year the rate of regression in size decreased. The number of cases followed after two years is too small to be statistically significant. Interestingly, none of the Group I patients showed a return of heart size to normal.

Postoperatively, the pulmonary artery segment showed a prompt decrease in convexity. This was due in part to the repair of the defect, with resulting closure of the shunt, but probably also to postoperative changes in the mediastinum, which obscured the prominence of the pulmonary artery segment. After two months most of the cases showed a slight increase in the pulmonary artery prominence as compared to the immediate postoperative examination, but not to the degree noted preoperatively. During the succeeding examinations the pulmonary artery segment continued to become somewhat smaller.

Three-fourths of all patients showed an increase in the pulmonary vascularity in the immediate postoperative period. This was thought to represent varying degrees of passive venous congestion with inability to differentiate accurately between the pulmonary venous and arterial pattern. As expected, in the cases in which preoperatively there was a left-to-right shunt there was a progressive decrease in the prominence of the pulmonary vessels after closure of the defect. The number of patients in whom the preoperative shunt was predominantly right to left was too few for statistical evaluation. An interesting change in the postoperative roentgen appearance in approximately one-third of the infants in this series was an increase in size of the thymic shadow several months after surgery. This apparently is a reflection of the improvement in the clinical status of these patients.

SUMMARY

Isolated ventricular septal defects may be classified according to the ratio of the systolic pulmonary artery pressure to the systolic systemic pressure and according to the magnitude and direction of the shunt through the septal defect. A comparison of the radiographic findings in 144 cases, consisting of an estimate of the cardiac size, prominence of the undivided pulmonary artery segment and pulmonary vascularity, and size of left atrium with this classification shows a characteristic pattern which has been presented.

The radiographs of 133 patients undergoing surgical closure of the defect were evaluated in respect to these same roentgen features and the changes which occurred over a period of two years following surgical closure are described.

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SUMMARIO IN INTERLING UA

Evalutation Radiologic de Isolate Defectos Ventriculo-Septal Ante e post lor Clausion Chirurgic

Isolate defectos ventriculo-septal pote esser classificate secundo le proportion inter le systolic pression pulmono-arterial e le systolic pression in le circulation systemic e secundo le magnitude e le direction del shunting a transverso le defecto septal. Un studio comparative del datos radiographic de 144 casos—con attention prestate al dimensiones cardiac, al prominentia del nondividite segmento pulmono-arterial e del vascularitate pulmonar, e al dimensiones del atrio sinistre—permitte le recognition de un schema characteristic.

Quando le pression pulmonar es normal e le shunting pauco importante, le aspecto radiographic del corde e del vasculatura pulmonar es usualmente normal; allargamento del atrio sinistre es rar. Quando le pression in le arterias pulmonar es elevate a plus que 50 pro cento del pression systemic e quando il existe un grande shunting sinistro-dextere, le atrio sinistre es allargate e le arteria pulmonar e le vascularitate pulmonar deveni plus prominente. Allargamento sinistro-ventricular es predominante, sed un certe numero de casos exhibi combinate hypertrophia ventricular. Le casos in que le tension pulmono-systolic es approximativemente equal al tension systemic e in que il existe un grande shunting sinistro-dextere, manifesta le aspectos del previe gruppo in forma accentuate e, in plus, un plus alte grado de hypertrophia e dilatation dextero-ventricular. In le presentia de approximativemente equilibrate tensiones systolic pulmonar e systemic e un micre shunting sinistro-dextere o un moderate shunting dextero-sinistre, le dimensiones general del corde es reducite, le hypertrophia dextero-ventricular es plus pronunciate, e le atrio sinistre es minus prominente. Le marcation periphero-vascular es usualmente normal o levemente reducite, sed le arteria pulmonar es frequentemente de prominentia inusual.

In le gruppo in que le shunting es completemente dextero-sinistre, allargamento sinistro-atrial es inusual, e le marcation pulmonar es frequentemente reducite. Le segmento pulmono-arterial es grande, sed le dimensiones general del corde es normal o, in multe casos, subnormal.

Radiogrammas obtenite ab 133 patientes in qui un defecto ventriculo-septal habeva essite claudite chirurgicamente esseva evalutate, e le alterationes observate in le curso de un periodo postoperatori de duo annos es describite. A generalmente parlar, un augmento immediate del dimensiones cardiac esseva sequite per regression, con le plus alte grado de melioration occurrente in le patientes qui ante le operation habeva habite le plus grande cordes. Esseva notate un prompte reduction in le convexitate del segmento pulmono-arterial. In patientes con shunting sinistro-dextere, le vasos pulmonar manifestava un reduction progressive del prominentia post le clausion del defecto.

(For Discussion of this paper, see following page)

DISCUSSION

(Papers by Lehman, Lemmon, Boyer, and Fitch; Singleton, McNamara, Leachman, Cooley, and Chau)

F. J. Lewis, M.D. (Chicago, Ill.): I am a surgeon who does cardiac surgery, and I am glad to comment on these two interesting papers.

Dr. Lehman's paper recalls to me, with some amusement, the reaction of my associates and myself a number of years ago when we first heard that right heart catheterization was being done. At that time I was a resident in internal medicine in a British hospital. We were disturbed and, indeed, could not quite believe it. Now, in common with all of you, I think that I accept news of a bold new diagnostic technic such as Dr. Lehman and his associates have described with some warmth and an open mind.

The importance of these diagnostic procedures is great, particularly to the surgeon, and I think we must recognize that a diagnostic procedure can justifiably carry some risk. Certainly if heart operations are done without a correct diagnosis, and for that reason nothing can be accomplished at the time of surgery, a great risk is involved. Some risk associated with diagnostic procedures should therefore be accepted.

I should like to point out, too, that, despite the contributions of a number of radiologists in outlining the coronaries and the ascending aorta, diagnosis in these areas is still not sufficiently precise. In respect to potential surgery for coronary occlusion, it is possible that the most important use of arteriographs may be for postoperative evaluation. We already know that almost any candidate for coronary surgery has extensive involvement of the coronary arteries. In fact, in our pathological studies this has been found to be true of almost anyone over the age of fifty. A surgeon could therefore expect to find extensive disease whether or not it was demonstrated arteriographically. Postoperatively, however, we need information such as can be provided by arteriograms, since clinical and electrocardiographic evaluations are not adequate for determination of the effectiveness of surgery.

Dr. Singleton and his associates have certainly given us important information concerning some puzzling aspects of ventricular septal defects. Many questions could be asked regarding their presentation. I should like particularly to know if the roentgenographic findings paralleled the postoperative catheterization studies and if it was possible to conclude whether or not the defect had been satisfactorily closed from roentgen examination alone. Concerning the striking picture of early heart failure shown by the essayist after some operations, I should like to know if some of that failure might not be due to the incision in the right ventricle.

I believe that is all I have to say beyond complimenting both essayists on their presentations.

The Relationship of the Cardiac Silhouette to Altered Respiratory Dynamics in Congenital Heart Disease in Infants[1]

LAWRENCE A. DAVIS, M.D., and MARGARET VERMILLION, M.D.

THE RELATIONSHIPS of cardiac size and contour to respiratory dynamics in infants and the newborn who are suffering from the "bronchiolitic syndrome" are well known. Briefly, during the height of this inflammatory disease there are marked overventilation of the thorax with depression and flattening of the diaphragm, an increased anteroposterior thoracic diameter, bulging of the sternal plate anteriorly, and frequently widening of the rib interspaces. The cardiothoracic ratio during this period is markedly reduced, and there is actually a reduction in the overall roentgen size of the heart. There may also be changes in its configuration.

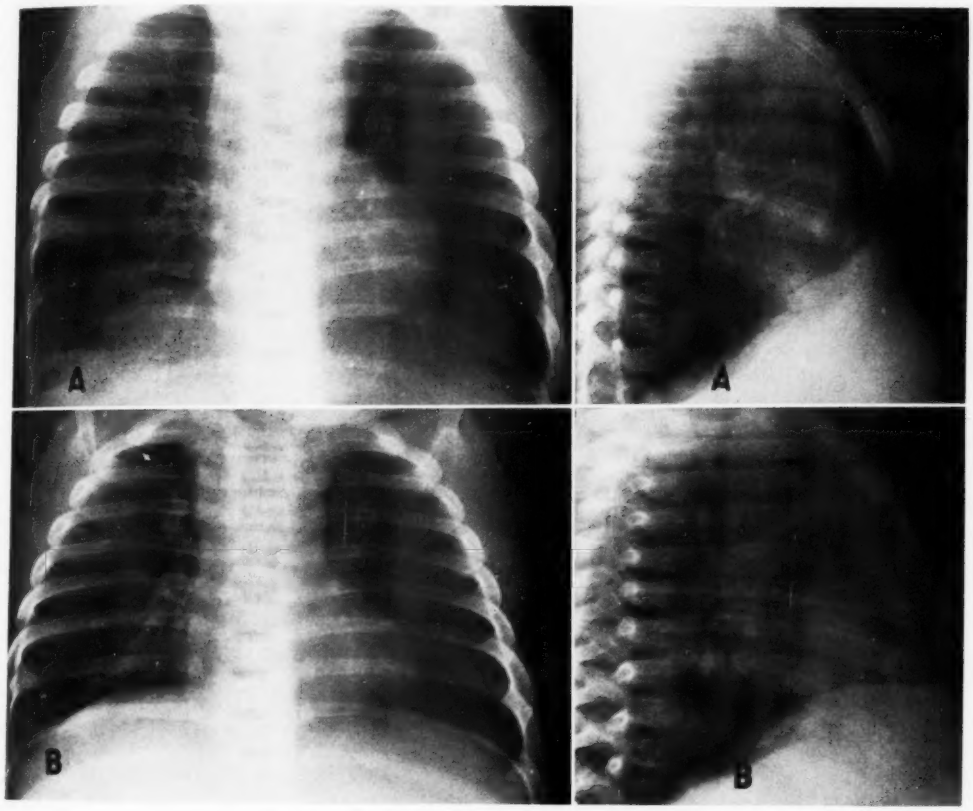


Fig. 1. Four-month-old male with bronchiolitis.

A. The diaphragm is markedly depressed. The apex of the heart appears to be elevated. The relations of the heart to the anterior chest wall are disturbed by the hyperaerated lungs. The pulmonary arterial tree branches are spread apart by the process.

B. Ten days later. Clinical remission of all symptoms. The thorax has resumed its normal contour. The "apex" has returned to a normal position. The lungs are now normally vascularized in appearance.

[1] From the Departments of Radiology and Pediatrics, the Children's Hospital, and the University of Louisville Medical School, Louisville, Ky. Presented as part of a Symposium on Cardiovascular Roentgen Diagnosis at the Fourty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958.

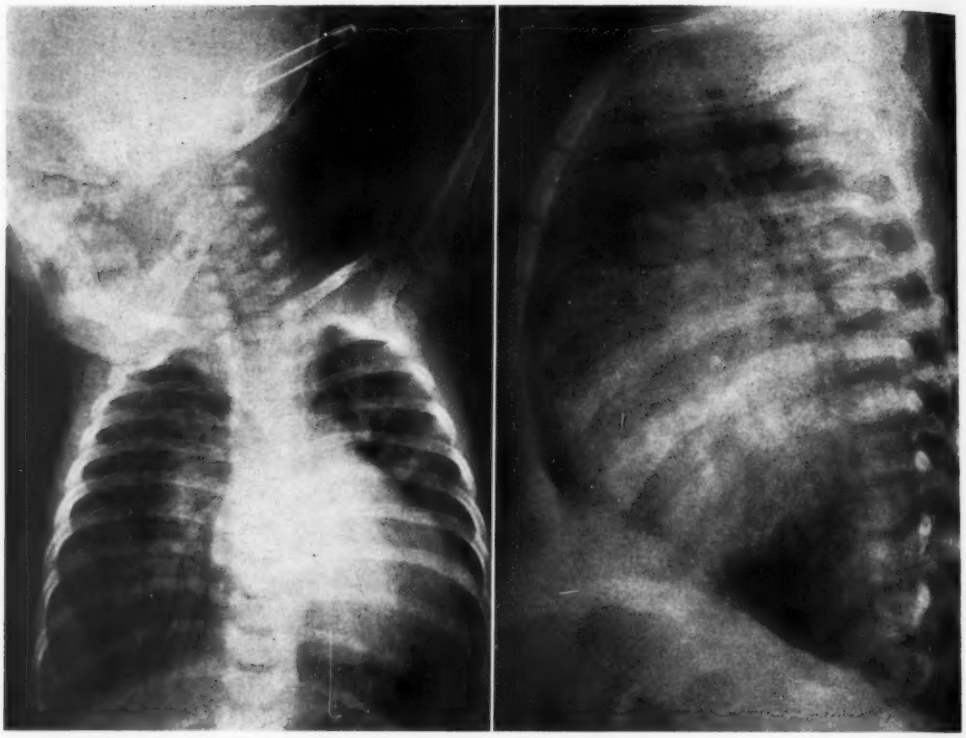


Fig. 2. Male aged seven months with transposition of the great vessels; anteroposterior and lateral views. There is tremendous overinflation of the lungs, as shown by flattening of the diaphragm and increased anteroposterior thoracic diameter.

If criteria for specific chamber enlargement depend either on the actual outline and configuration of the heart or upon its relation to the chest wall (1), these relationships are seriously disturbed merely because of change in the thoracic contour and not necessarily as a result of any intrinsic cardiac abnormality. These changes are well illustrated in Figure 1, A, which shows an infant chest during an attack of bronchiolitis. In Figure 1, B the chest is seen following recovery. The marked difference in cardiac contour is apparent.

Several authors have realized the difficulty of accurate chamber analysis in infants. Sussman and Jacobson (2), in a well controlled study, showed the difficulty of evaluation of right ventricular enlargement, but their series did not include infants. Others have written on the relation of emphysema and left-to-right shunt (3) but have not emphasized the relationship of heart size and configuration to these changes. Friedman and Ash (4) specifically mentioned overdistention of the lungs in 8 of 11 infants with a persistent atrioventricular canal. Maxwell (5) discussed the clinical appearance of Harrison's grooves in a patient with ventricular septal defect and relates it to the dyspnea. Still other writers have commented on the problems involved in particular chamber analysis in various congenital heart diseases (6–8). Recently, Lambert, Perez, and Vlad (9) discussed emphysema in infants with congenital heart disease and demonstrated a significant lowering of the diaphragmatic level as compared with normal controls. This was associated with a changing cardiothoracic diameter and inferior displacement of the liver.

As one analyzes films of infants with

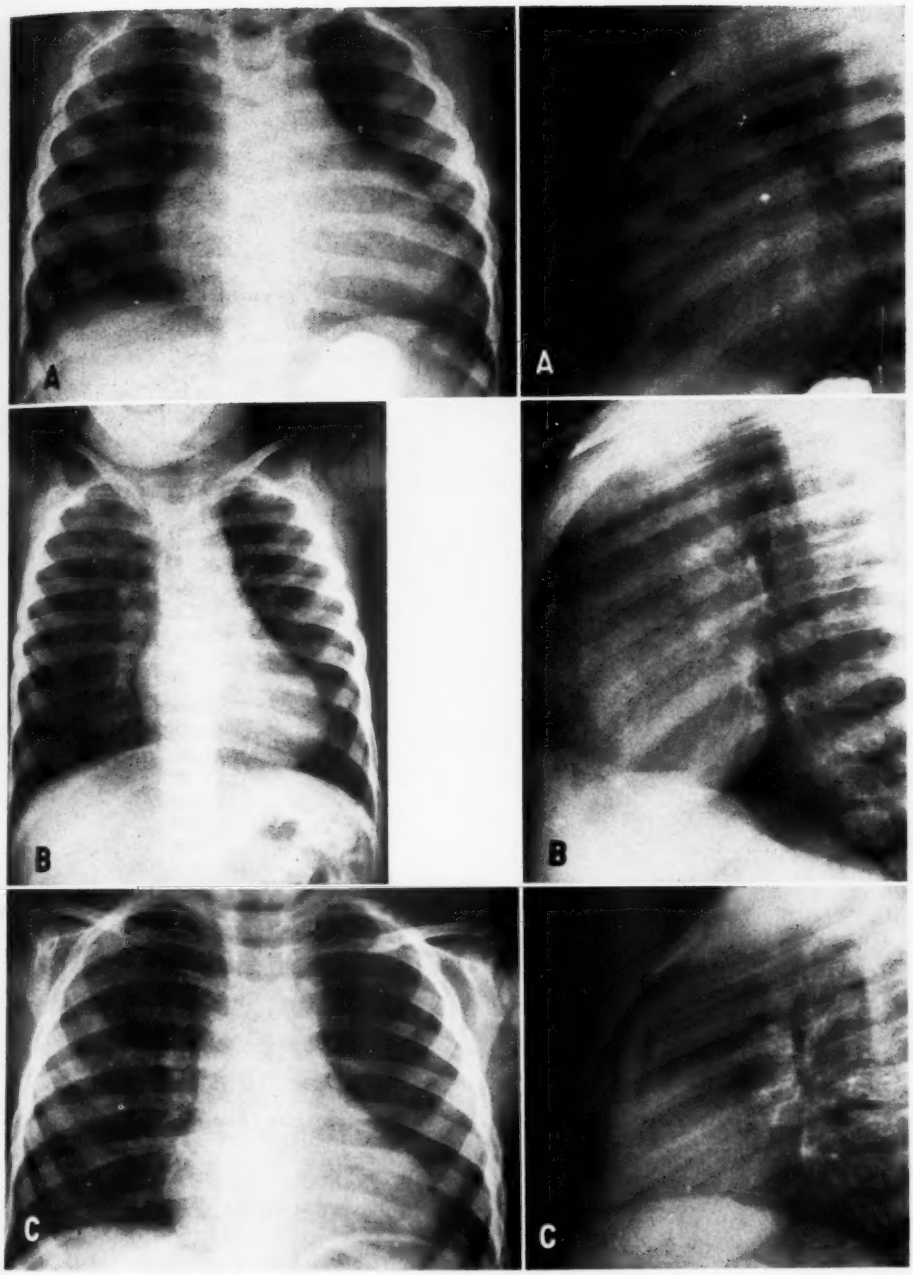


Fig. 3. Male aged three years with tetralogy of Fallot.

A. On routine examination there is bulging of the heart posteriorly in relation to the spine.

B. Age, three years, five months. Patient admitted to the hospital with an attack of "bronchiolitis" characterized by dyspnea, cough, and fever. The heart configuration has changed markedly because of the pulmonary overinflation.

C. Five days later. The patient has clinically recovered from his respiratory infection. The heart configuration is now similar to that noted in A.

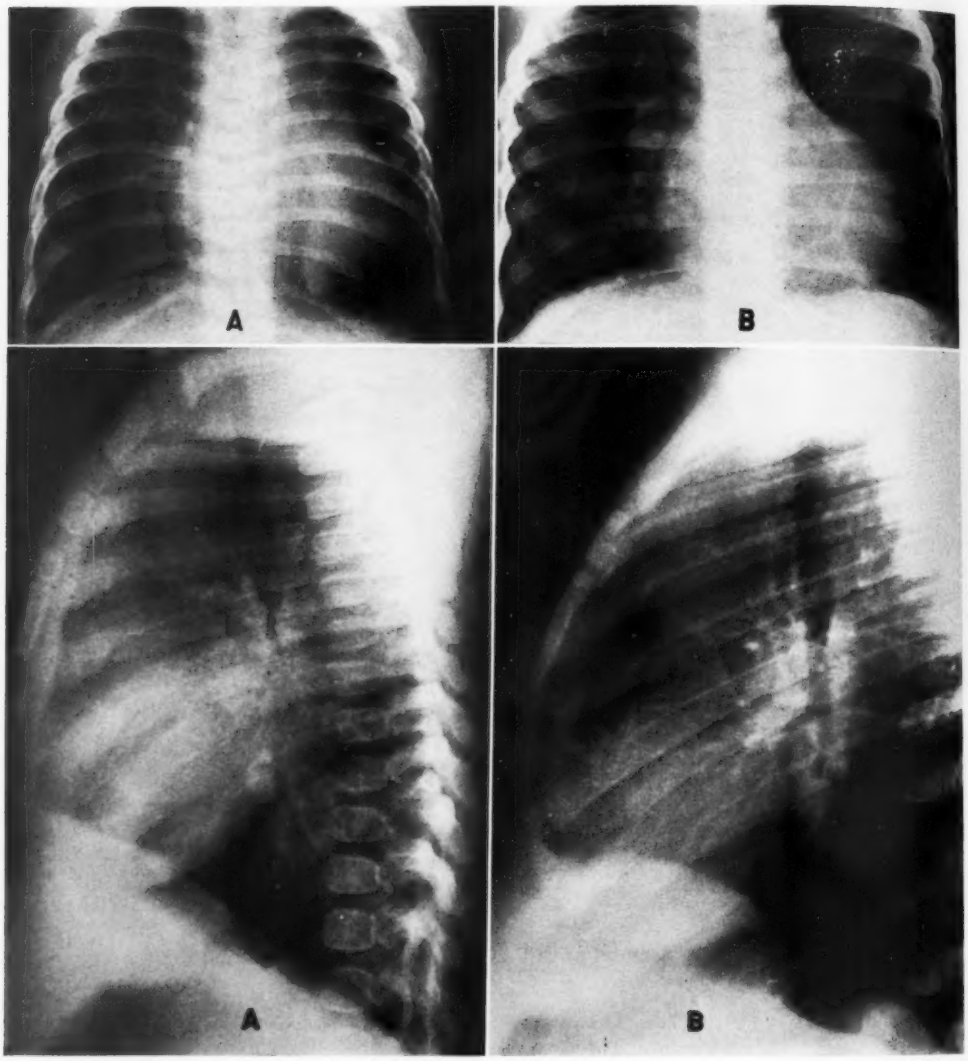


Fig. 4. Male aged 4 months with coarctation of aorta.

A. Patient was in heart failure at ten days of age and was on digitalis at the time of this examination. The hyperinflated lungs with depression of the diaphragm have caused an "elevation of the cardiac apex."

B. At three years the patient was well compensated, having had no drug therapy since the age of fifteen months. The lungs are now normally aerated, with a consequent change in the heart contour.

severe cardiac abnormalities, either those demonstrating a large left-to-right shunt or, occasionally, those with a marked pulmonic stenosis, the frequency of over-aeration is striking. Similar thoracic abnormalities secondary to the hyperinflation of the lungs are noted in these infants, resembling those described in the "bronchiolitic syndrome." Though, as has been mentioned, hyperinflation has not been stressed, many of the illustrations in articles dealing with congenital heart disease in infants show these changes to be present.

Probably the most logical explanation for this pulmonary hyperventilation is that offered by Wittenborg (10). To compensate for poor oxygenation of the blood one

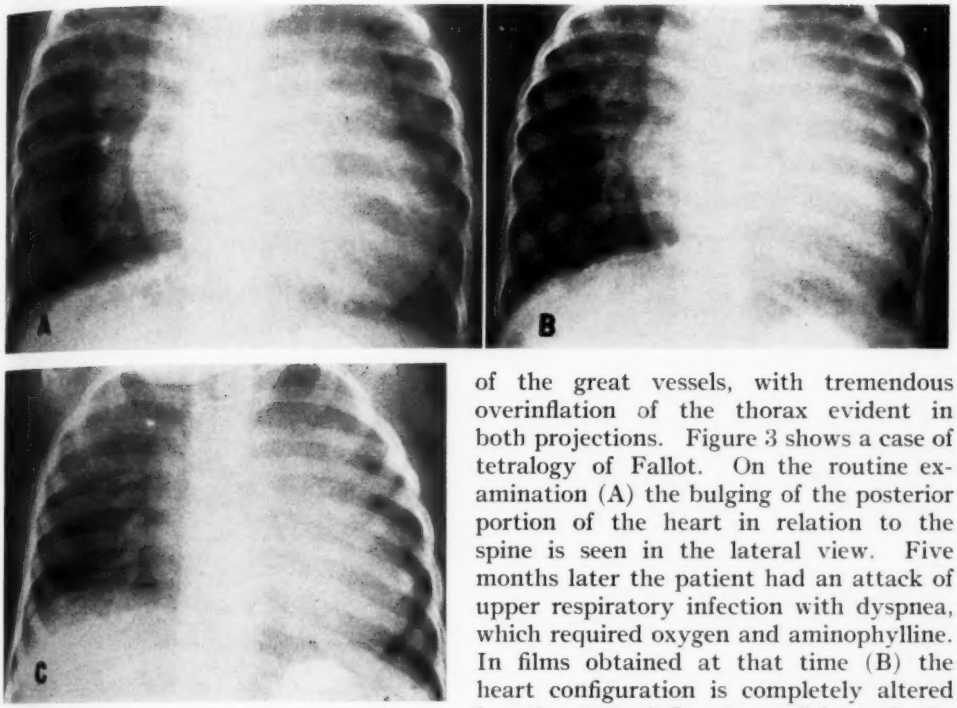


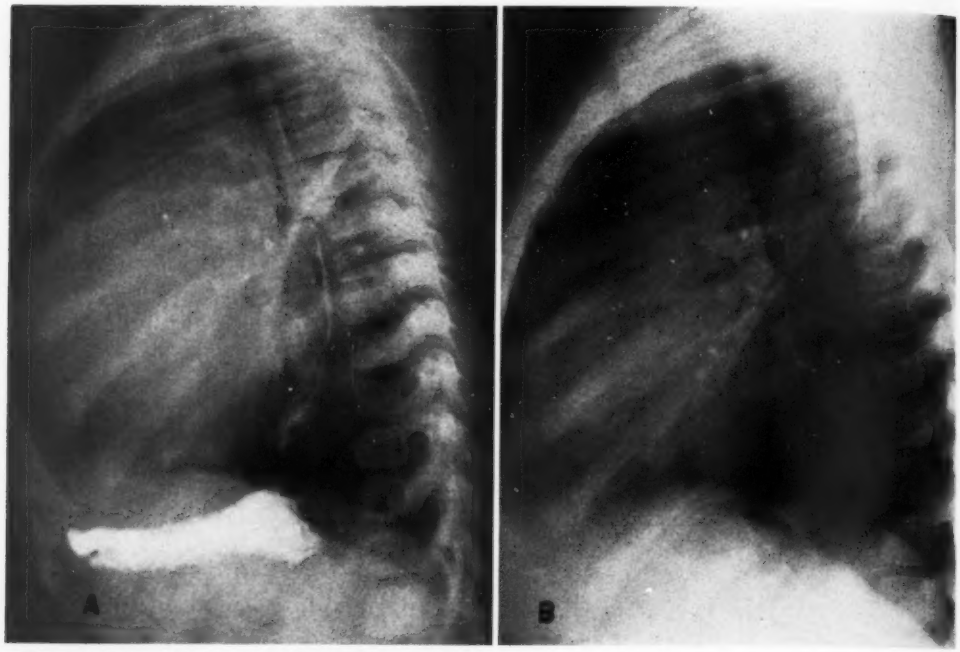
Fig. 5. Six-month-old female, with patent ductus.
A. Patient in clinical difficulty. The lungs are tremendously overaerated.
B. Two months later. The constancy of the finding noted in A is demonstrated.
C. Two years following ligation of the ductus (age, two years, nine months). Patient is clinically asymptomatic. The pulmonary aeration is normal. Film made in slight expiration. This may account for the apparent lack of reduction in heart size as compared with the preoperative film.

of the earliest mechanisms called into play is hyperventilation. Since inspiration is an active process and expiration a passive one, a small residual increment of air is trapped in the lungs during each respiratory cycle when the respiratory rate is so high that there is not time for full expiration. A similar explanation applies, in part, to those patients with pure inflammatory disease of the lungs, the hyperventilation there, also, being a compensatory mechanism as well as secondary to increased airway resistance.

Figures 2 and 3 illustrate classical hyperinflation of the lungs in children suffering from congenital heart disease. Figure 2 shows a patient with transposition of the great vessels, with tremendous overinflation of the thorax evident in both projections. Figure 3 shows a case of tetralogy of Fallot. On the routine examination (A) the bulging of the posterior portion of the heart in relation to the spine is seen in the lateral view. Five months later the patient had an attack of upper respiratory infection with dyspnea, which required oxygen and aminophylline. In films obtained at that time (B) the heart configuration is completely altered by the hyperinflated condition of the thorax. Figure 3, C shows a return to normal appearance following resolution of the inflammatory lung disease.

It is evident that analysis of the cardiac contours in the various projections, without reference to the state of pulmonary inflation at the time of the exposure, may make comparison between examinations inaccurate.

Changes in degree of pulmonary hyperinflation may occur secondary to the natural progress of the disease, medical therapy, or surgical intervention. In Figure 4 the chest films of a patient with coarctation of the aorta are reproduced. This patient was in heart failure at ten days of age and was digitalized at that time. The films, taken at the age of four months (A), show a hyperinflated chest with elevation of the apex which is probably spurious and secondary to the marked depression of the diaphragm. The patient was taken off digitalis, at the age of fifteen months, and a film at the age of three years (B) shows normal aeration of the lungs and a



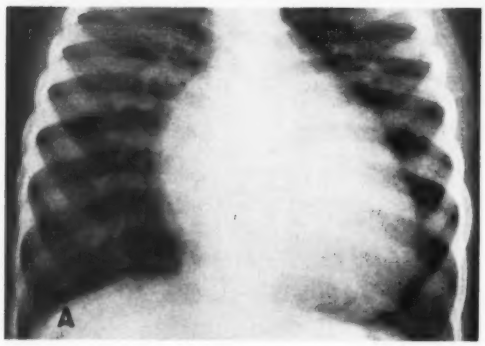


Fig. 6. Female, aged one year, five months with symptomatic patent ductus.
A. Marked pulmonary overinflation.
B. Nine months postoperative. Patient asymptomatic. Return to normal aeration of the lungs.

change in cardiac configuration, probably at least in part secondary to this.

Figure 5, A shows the chest of a six-month-old infant with a large patent ductus, and with tremendous hyperinflation of the lungs. Figure 5, B illustrates the constancy of this finding two months later. In Figure 5, C, a film obtained two years following division of the ductus, normal aeration of the lungs is noted; in part because of the relative state of expiration at the time of its exposure, the heart does not appear to be tremendously reduced in size from the preoperative films. Figure 6 shows another child with a large symptomatic patent ductus, with hyperinflated lungs and post-operative return to normal aeration and change in the cardiac configuration.

It should be noted that in children with these findings expiration is inhibited and the films will always be in the inspiratory phase. In those children with normal aeration the film may be taken in expiration merely as a technical consideration.

Undervascularization of the lungs may be apparent rather than real if the over-inflation of the lungs is large and the spreading of the pulmonary vessels is great. This may explain, in some cases, why the diagnosis of undervascularization of the lungs is more inaccurate than that of overvascularization (11).

It should again be emphasized that an apparent increase in heart size following successful surgical interruption of a left-to-right shunt may merely be due to the

fact that the film is taken in slight expiration or, at least, expiration relative to the preoperative film.

SUMMARY

Analysis of cardiac contour and size in infants with congenital heart disease should be correlated with the degree of pulmonary hyperventilation. Hyperventilation is very frequent in those infants and children who have symptomatic congenital heart disease of a severe nature. The changes incident to overaeration may increase as the disease increases or may subside secondary to either surgical correction or medical therapy.

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SUMMARIO IN INTERLINGUA

Le Relation Inter le Silhouette Cardiac e Alterationes del Dynamica Respiratori in Congenite Morbo Cardiac de Infantes

Le analyse del silhouette e del dimensiones cardiac de infantes con congenite morbo cardiac deberea esser correlationate con le grado de hyperventilation pulmonar. Hyperventilation occurre frequentemente in infantes e juveniles con symptomatic congenite morbo cardiac de natura sever e es capace de alterar completemente le configuration del corde vidite in le examine roentgenographic. Le alterationes associate con hyperaeration resimila illos del syndrome bron chiolitic; illos pote augmentar se con le progresso del morbo; illos etiam pote subsider in consequentia de un correction chirurgic o post medication. Il es evidente que le analyse del silhouette cardiac in varie projectiones sin referentia al stato del inflation pulmonar al tempore del exposition pote resultar in inaccuratias del comparation de plure examines.

The Importance of the Lateral View in the Evaluation of Left Ventricular Enlargement in Rheumatic Heart Disease[1]

WILLIAM R. EYLER, M.D., DAVID L. WAYNE, M.D., and JOHN E. RHODENBAUGH, M.D.

SURGICAL RELIEF for patients with mitral valve lesions resulting from rheumatic fever is still much more effective in mitral stenosis than in mitral insufficiency; the surgical approach to mitral insufficiency is used only to a limited extent. The estimation of the degree of insufficiency in a mitral lesion is thus an important factor in determining whether or not a patient will benefit from surgery. In addition, those patients who are to undergo operation for mitral insufficiency will frequently require pump-oxygenator apparatus. The detection of enlargement of the left ventricle in the lateral view has been the most reliable single indicator of mitral insufficiency in our material.

The fact that enlargement of the left ventricle occurs more posteriorly than laterally has long been recognized (8). Indeed, this is implicit in the evaluation of left ventricular size in the left anterior oblique projection. Less attention has been given to the lateral view. McKay and Aitchison (6) made use of the esophagus as a landmark in detecting posterior enlargement of the left ventricle. They described a translucent space between the heart and lower esophagus in a high percentage of cases of pure mitral stenosis but found this less frequently in the presence of an associated lesion capable of causing left ventricular hypertrophy. Jacobson and others (3) have made similar

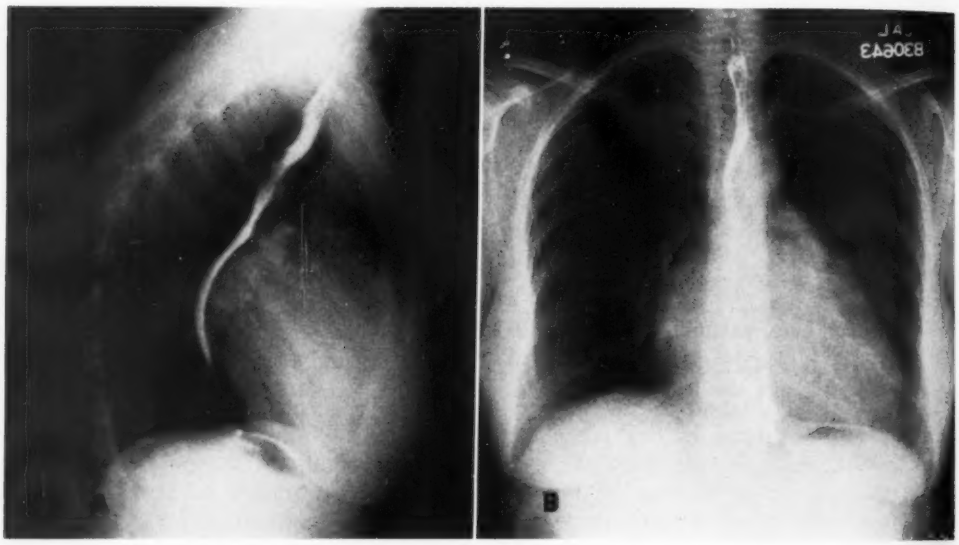

Fig. 1. Left lateral and postero-anterior views in a case of pure mitral stenosis.
A. There is a short segment of heart in contact with the diaphragm, with a C/D ratio of 0.38. The left atrial impression on the esophagus is of moderate length.
B. The postero-anterior view shows increased transverse cardiac diameter, with the apex of the heart in normal position. There is some upper lobe venous distention.

[1] From The Henry Ford Hospital, Detroit, Mich. Presented as part of a Symposium on Cardiovascular Roentgen Diagnosis at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958.

observations. Dealy (1) has used the typical shape of the heart in the lateral projection as one of his criteria. Lehman and Curry (5) described the appearance of the heart in the lateral view at some length; particularly pertinent to this study is their description of the "intrusion" of the heart into the postero-inferior cardiac recess. They felt that they could not distinguish whether atrium or ventricle was responsible for this configuration.

We have re-examined the films of 214 cases of rheumatic valvular disease, surgically explored, for which suitable lateral views of the chest were available. In this material, the lateral view of a patient with mitral stenosis usually shows a short segment of the heart in contact with the left leaf of the diaphragm (Fig. 1, A). The posterior aspect of the heart is of a sigmoid shape, there is often a clear space between the heart and the barium-filled esophagus, and the heart does not protrude more than 10 mm. behind the upper end of the inferior vena cava. The postero-anterior view (Fig. 1, B) shows upper lobe venous distention but, in spite of obvious increase in transverse cardiac diameter, there frequently does not appear to be any definitely abnormal position of the apex.

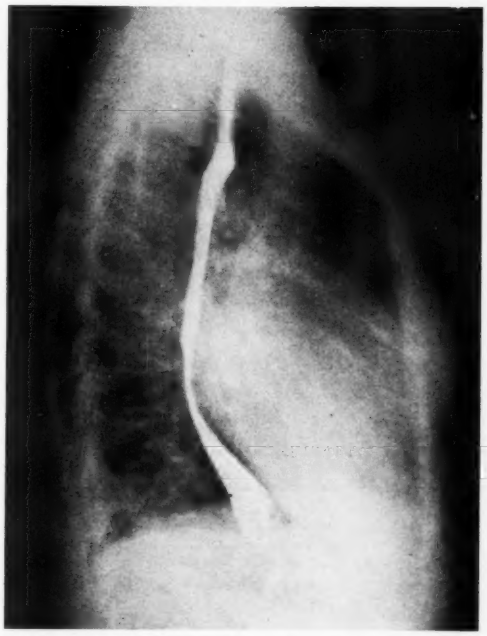

Fig. 2. Left lateral view. Pure mitral stenosis. The atrial impression on the esophagus is longer in this case and the inferior border of the left atrium is less well defined than in the case shown in Fig. 1, but there is a short segment of heart in contact with the diaphragm. The C/D ratio is 0.32.

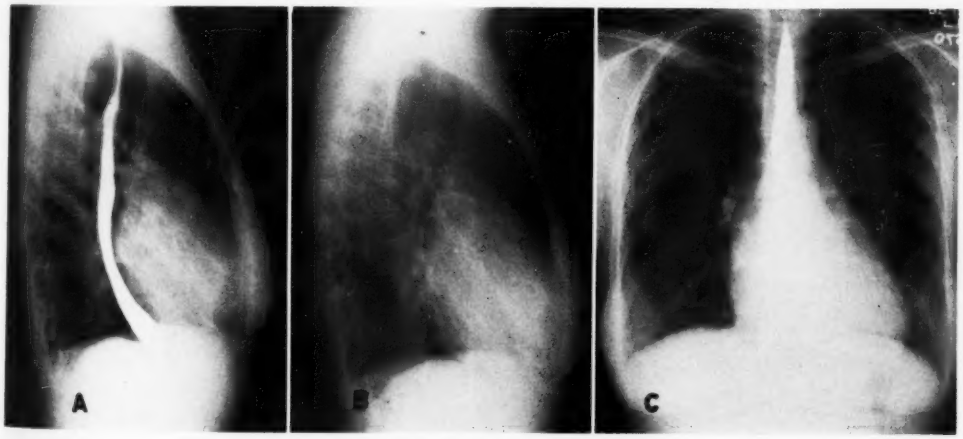

Fig. 3. Left lateral and postero-anterior views. Mitral stenosis with moderate mitral insufficiency.
A. C/D ratio cannot be measured because barium obscures the posterior portion of the cardiac segment in contact with the diaphragm.
B. The film without barium shows the landmarks clearly. The C/D ratio measures 0.53. Note the posterior extension of the left ventricle which extends behind the inferior cava for a distance of 20 mm.
C. The postero-anterior view shows a relatively normal vascular pattern in the lungs and lack of definite evidence of left ventricular hypertrophy.

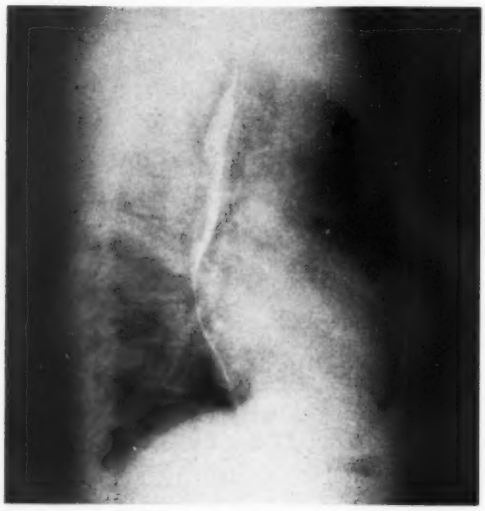

Fig. 4. Left lateral view. Mitral stenosis with aortic stenosis. The enlarged left ventricle resulting from the aortic stenosis extends posteriorly, enlarging the diaphragmatic segment of the heart (C/D ratio 0.55) and extending 25 mm. behind the inferior cava.

Not all these features, however, are incorporated in the lateral view in every case of pure mitral stenosis. Figure 2 illustrates a longer left atrial impression on the esophagus and absence of the clear space between the heart and esophagus as well as loss of the exact location of the inferior border of the left atrium. It does show a short segment in contact with the diaphragm.

In the presence of mitral insufficiency, an aortic valve lesion leading to left ventricular hypertrophy, or systemic hypertension, the posterior enlargement of the left ventricle causes the segment of heart in contact with the diaphragm to lengthen (Figs. 3, B and 4). The left ventricle forms a convex shadow posteroinferiorly and usually extends beyond the upper end of the inferior vena cava for a distance of at least 15 mm. measured in the horizontal plane. The postero-anterior view in such a case (Fig. 3, C) may show only minimal change in the configuration of the apex.

The proper evaluation of the size of the cardiac chambers requires the use of all

Fig. 5. Left lateral and postero-anterior views. Mitral stenosis with moderate mitral insufficiency.
A. The lateral view in all respects is consistent with mitral stenosis; the C/D ratio is 0.37.
B. The postero-anterior view shows an obvious convexity of an enlarged left ventricle. In this patient the apex has rotated anteriorly, so that the left ventricular hypertrophy is well seen in this view, but is hidden in the lateral view. It is necessary to make use of all four views of the heart in evaluating cardiac chamber size.

four projections and fluoroscopy. Figure 5, A is a lateral view which in all respects is consistent with pure mitral stenosis; yet inspection of the postero-anterior view (Fig. 5, B) shows obvious convexity of an enlarged left ventricle. In this patient the apex of the heart has rotated anteriorly so that the left ventricular enlargement is hidden in the lateral film, but is readily apparent in the postero-anterior projection.

Measurements are obtained by the following method. The lateral view is placed so that the thorax is vertical. The internal diameter of the chest (D) is measured horizontally from the anterior to the posterior pleural surface, and the length of the cardiac segment (C) from the anterior pleura to the posterior point of contact between the heart and the left leaf of the diaphragm is determined (Fig. 6). A ratio (C/D) of these two distances is obtained.

The patients are subsequently divided into four categories on the basis of surgical findings and the data obtained, plotted as in Figure 7. The C/D ratio of 0.42 provides a good boundary between stenosis and other lesions. The first group consists of patients having "pure" mitral stenosis (86 with a C/D ratio of 0.42 or below; 12 with a ratio above 0.42); the second group, of those with stenosis accompanied by minimal insufficiency (23 below and 11 above 0.42); the third group, of those with stenosis and moderate insufficiency (10 below and 17 above 0.42); and the fourth, of those with marked insufficiency, those with associated aortic valve lesions and with pure aortic valve lesions (15 below and 40 above 0.42).

Several difficulties in obtaining these measurements have been encountered. If the esophagus contains a large amount of barium (Fig. 3, A), the posterior limit of the zone of contact of the heart with the left leaf of the diaphragm may be obscured; such a film is not suitable for measurement. Likewise fluid in the left pleural space obscuring the left leaf of the diaphragm or deformity of the left leaf of the diaphragm makes it impossible to obtain a satisfactory measurement. When it is apparent by study of all four projections that the left atrium is huge, this method of estimating left ventricular size cannot be applied.

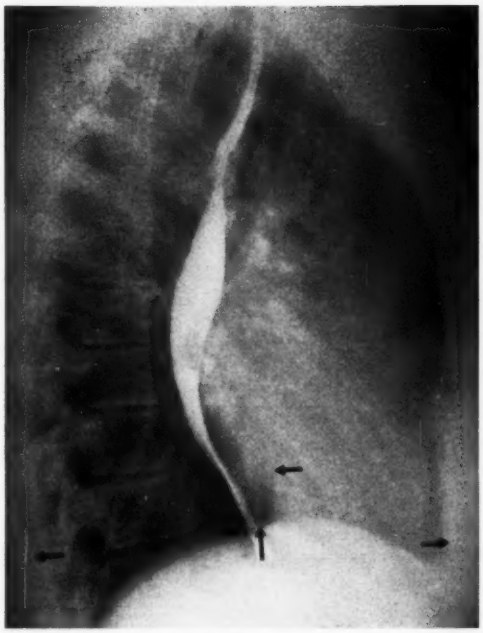

Fig. 6. Left lateral view of chest of a patient with pure mitral stenosis, showing reference points for measurement. The film is placed with the thorax as nearly vertical as possible. The internal diameter of the chest (D) is measured horizontally from anterior to posterior pleura. The length of the cardiac segment (C) from the anterior pleura to the most posterior point of contact between the heart and the left leaf of the diaphragm is measured, and a ratio of (C/D) determined. An additional measurement of the horizontal distance from the upper end of the inferior vena cava to the posterior heart border is made.

DISCUSSION

It is obvious from the overlap of measurements in the various types of lesion that complete separation and differential diagnosis cannot be made on the basis of the measurements described alone. In evaluating the patient from the radiological point of view, all views are considered and attention is paid to the pattern of the pulmonary vessels following the suggestions of Kerley (4), Simon (9), and Ormond and Poznanski (7). When the

radiological and clinical impressions agree, the selection of therapy has been made on the basis of the combination of these two lines of approach. When there has been disagreement, or the findings from the two types of approach are not conclusive, the patients have been subjected to left heart catheterization by Fisher's (2) modification of Björk's method.

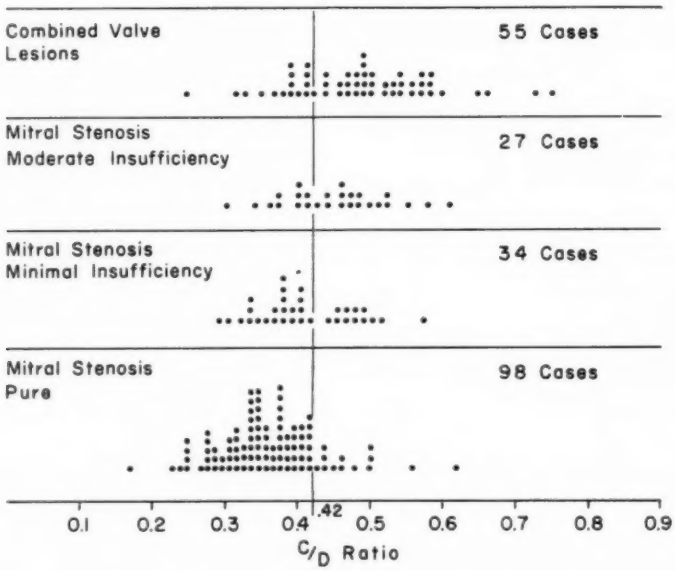

Fig. 7. Data Summary. The values of the C/D ratio in all the cases studied are plotted. The description of the lesion is that of the surgeon. The category "combined valvular lesions" includes cases of mitral stenosis with marked mitral insufficiency or pure mitral insufficiency cases with involvement of mitral and aortic valves, and aortic valve lesions. The mean of the ratios in each category was determined and the grand mean found to be 0.42. Inspection of the data shows this figure to be a good dividing line between cases with and without left ventricular hypertrophy.

It is not the purpose of this paper to suggest that the C/D ratio 0.42 be rigidly employed. Rather this is an attempt to define the range of values and the reliability of this sign and to recommend the subjective employment of this criterion.

SUMMARY

1. In patients with rheumatic lesions of the mitral valve, the detection of left ventricular enlargement in the lateral view has been the most reliable single roentgen indication of the presence of mitral insufficiency or of an aortic valve lesion. All four views as well as fluoroscopy should be used.

2. The ratio of the length of the segment of the heart which intersects the left leaf of the diaphragm to the internal diameter of the chest has been determined on a lateral view of the chest. Those cases with a ratio of 0.42 or less have usually not had enlargement of the left ventricle. In those with a ratio above 0.42 the left ventricle has usually been enlarged.

3. When the left ventricle was enlarged, it has in most cases projected behind the shadow of the inferior vena cava for a distance of 15 mm. or more.

4. Patients with a giant left atrium or deformity of the left hemidiaphragm cannot be evaluated by this method.

5. All roentgen signs must be combined; when the roentgen information agrees

with the clinical, further study such as left heart catheterization is not required.

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SUMMARIO IN INTERLINGUA

Le Importantia del Aspecto Lateral in le Evalutation de Allargamento Sinistro-Ventricular in Rheumatic Morbo Cardiac

In patientes con lesiones rheumatic del valvula mitral, le autores ha trovate que allargamento sinistro-ventricular manifeste in le aspecto lateral esseva le indication individual le plus fidel pro le presentia de insufficientia mitral o pro un lesion del valvula aortic. Tamen, pro le adequate evalutation del dimensiones del cameras cardiac, omne le quatro projectiones e le uso de fluoroscopia es indispensabile.

Le proportion inter (1) le longor del segmento cardiac que interseca le lobo sinistre del diaphragma e (2) le diametro interne del thorace esseva determinate in projectiones lateral de circa 214 casos de rheumatic morbo valvular. Le patientes in qui ille proportion non esseva plus que 0,42 non habeva, usualmente, allargamento del ventriculo sinistre, durante que in patientes in qui ille proportion excedeva le valor mentionate, le ventriculo sinistre esseva generalmente allargate.

Quando le ventriculo sinistre esseva allargate, il esseva trovate in le majoritate del casos que illo se projiceva in retro del umbra del vena cave inferior per un distantia de 15 mm o plus.

Patientes con un gigante atrio sinistre o deformitate del hemidiaphragma sinistre non pote esser evalutate per iste mesme methodo.

Omne le signos roentgenographic debe esser prendite in consideration in le evalutation de rheumatic morbo valvular. Quando le observationes roentgenologic e clinic se trova de accordo, studios additional, per exemplo catheterismo sinistro-cardiac, non es necessari.

The Utilization of Radioactive Zinc and Manganese in an Effort to Visualize the Pancreas[1]

I. MESCHAN, M.D., JAMES L. QUINN, RICHARD L. WITCOFSKI, and THOMAS A. HOSICK

FROM TIME TO TIME various substances have been shown to concentrate selectively in the pancreas, but thus far no useful nonsurgical means for pancreatic visualization for clinical study has been demonstrated.

In 1929, Crandall, Oldberg, and Ivy reported on a large number of dyes which concentrated moderately selectively in the pancreas, but at that time they could foresee no useful clinical test which might be derived from these studies (1). In 1943, Sheline *et al.* (2) studied the distribution of radioactive zinc administered to mice and dogs and found it in highest concentration in the pancreas with considerable amounts also in the liver and kidneys. The zinc content in the pancreas was thought to be many times that necessary to account for its insulin content in the form of a zinc salt. In another study, Montgomery, Sheline and Chaikoff (3) showed the maximum amount of zinc 65 in the whole pancreas to be 3.1 per cent at eight hours. By the fourteenth day a large proportion had been excreted into the pancreatic juice (11 per cent). Very little was excreted in the bile. This selectivity of zinc for the pancreas was further demonstrated when it was shown that long continued ingestion of zinc oxide by cats and dogs in large daily doses (175 to 1,000 mg. for three to fifty-three weeks) produced fibrotic changes in the pancreas (4). On the other hand, Sherrill and Wick (5) showed in two groups of animals that radiation emitted by 10 microcuries of zinc 65 per week and 36 microcuries daily for forty-one days produced no pancreatic abnormalities and did not lead to diabetes after six months.

Manganese has also been shown to have an affinity for the pancreas and liver. This was demonstrated in 1952 by Burnett, Bigelow, Kimball, and Sheppard (6) and in 1947 by Sheppard, Wells, Hahn, and Goodell (7). These two groups of authors found the concentration to be similar in the pancreas and liver up to one hour; it remained high in the pancreas for five hours but receded more rapidly from the liver. Sheppard *et al.* (7), in the earlier investigation, showed the number of colloidal particles of manganese dioxide containing manganese 52 to be high in the liver, intermediate in the pancreas and kidney, and low in other organs including the spleen.

It was our object in the present study:

1. To determine the fate of manganese and zinc compounds in relation to the liver, pancreas, kidneys, and spleen of dogs, utilizing radioactive isotopes of these elements.
2. To determine whether characteristic uptake curves for these elements could be developed over the pancreas.
3. To determine whether radioactive scan studies could be helpful in delineating the liver and pancreas in dogs.

It was our hope that some of these studies might be helpful when extended to man.

CHOICE OF COMPOUNDS

The various compounds which we have thus far utilized in our effort to delineate the pancreas have been:

1. Manganese chloride, utilizing both manganese 54 and manganese 52.
2. Zinc chloride, utilizing zinc 65.
3. Zinc sulfadiazine, utilizing zinc 65.
4. Zinc complex of 3′- or 6′-aminofluorescein.

In addition we have tested I^{131}-tagged diiodotyrosine, and various iodinated fluo-

[1] From the Bowman Gray School of Medicine, Winston-Salem, N. C. Work supported by Grant #C-3026, National Institutes of Health and the United Research Fund Grant. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958.

rescein compounds, utilizing I^{131}. We have also performed I^{131}-tagged antibody experiments, to be described in a separate report.

Physical Aspects of Manganese 52 and 54: Manganese 54 is a cyclotron product with a half-life of 310 days. It decays by K capture to chromium 54, which then drops to its ground state by emitting x-ray radiations of 0.835 and 0.0054 Mev.

Manganese 52 exists in two isomeric states—one with a half-life of 21 minutes and the other of 6 1/2 days (8). For practical purposes the short-lived isomer may be omitted. The 6 1/2 -day isomer decays by both positron emission (35 per cent) and K capture (65 per cent), yielding radiations with the following energies: 1.09 Mev, 1.46 Mev, 0.73 Mev, and 0.56 Mev.

Natural manganese exists as manganese 55, and the only manganese isotope available from slow neutron activation is manganese 56 with a half-life of 2.6 hours—too short for practical consideration at present.

Physical Aspects of Zinc Isotopes: Zinc has five stable isotopes (10), the two most abundant being zinc 64 and zinc 66. The only readily available radioactive isotope of zinc is zinc 65, with a half-life of 250 days. It decays by positron emission and K capture. The positrons have a maximum energy of 0.4 Mev. The annihilation radiation and gamma ray energies are: 0.45, 0.65, and 1.0 Mev.

Biological Aspects of Interest in Relation to the Above Elements: Manganese is concerned with oxygen metabolism and enzymatic activation in mammals (11). Normal manganese output varies periodically with the feeding schedule in mice, rats, and dogs and appears proportional to the output of protein nitrogen. Enzymatic strength of pancreatic secretion is also proportional to the concentration of nitrogen (12). This, combined with the data of Sheppard *et al.*, would lead one to believe that manganese might furnish an accurate tool for pancreatic function assay.

The major zinc-containing proteins are insulin, uricase, and carbonic anhydrase. The zinc content of insulin is 0.3 to 0.6 per cent (12).

PROCEDURE

The general experimental procedure was as follows: When the pure element was employed, tracer doses of 100 microcuries were prepared to be administered intravenously in mongrel dogs. Standards for comparison were prepared at the same time.

On the basis of a number of prior autopsies and related x-ray studies, an area on the left posterior abdominal wall close to the pancreas was demarcated and over this an external scintillation counter was placed. A half-inch thallium-activated sodium iodide crystal with open collimation was applied. Counting was done so that a minimum of 10,000 counts were recorded. Similar counts were obtained over the right lobe of the liver in two demarcated areas, and on the thigh. Ordinarily these various counts were made in approximately three-minute sequences. The thigh counts were subtracted from the other counts as representing animal background.

The counts from these studies were compared to the standards *in vitro* at a distance of 25 cm., to afford a general concept of the radioactivity of the several areas relative to the dose administered. Such counts were repeated hourly for eight hours. Initially radioisotopic scans were done of the entire abdomen with a 1-inch sodium iodide crystal and a Francis-Bell spectrometer type scanner, but these were abandoned since no satisfactory scans were obtained.

Seventeen dogs were used for the zinc experiments, and 10 for the manganese experiments.

Observations were carried beyond the eight-hour interval in 2 dogs for zinc determinations at twenty-four hours, and in 2 dogs each for manganese at forty-eight hours, six days, seven days, and ten days. In addition, dogs were sacrificed in groups of 2 at two hours, four hours, six hours, and eight hours for each of the elements studied.

At the time of sacrifice, the kidneys, liver, pancreas, and spleen were removed

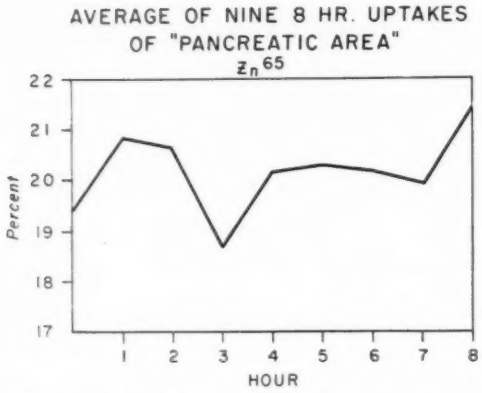
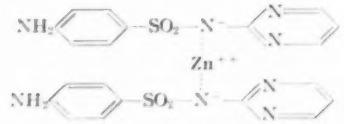


Fig. 1. Average hourly percentage uptake over the pancreatic area of 9 dogs studied for eight hours after the intravenous administration of 100 μc of zinc 65.

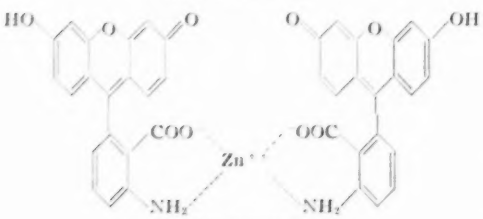
in toto and weighed, and an aliquot was taken for radioassay. The percentage concentration of the element in question in the aliquots (and calculation for the organ as a whole) was determined by comparison with the dose administered, according to the previously prepared standard. A deep-well scintillation counter was utilized for this concentration determination.

Gross autoradiographs were also obtained by four-day exposure of the whole organs to sensitive film.

The synthesis of the zinc 65 sulfadiazine and the zinc complex of 3′- or 6′-aminofluorescein



Zinc sulfadiazine



Possible structure of
zinc complex of 3′-aminofluorescein

was carried out in our own laboratory, and similar 100-microcurie tracer doses were employed in 1 dog each for these new compounds. Since, as will be shown, the results with these synthesized compounds were very similar to those with the pure elements, no further experiments were deemed desirable with these particular compounds.

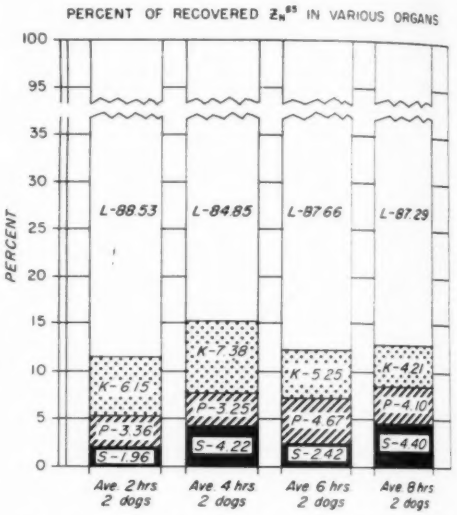


Fig. 2. Percentage of recovered zinc 65 in liver (L), kidneys (K), pancreas (P), and spleen (S) two to eight hours after the intravenous administration of 100 μc of zinc 65.

RESULTS

Zinc-65 Experiments: The curve shown in Figure 1 demonstrates the average uptake over the pancreas in the 9 animals studied for a minimum of eight hours. There was an early short rise in the first hour, a considerable drop between two and three hours, and a sharp rise to four hours, a plateau between four and seven hours, and another sharp rise between seven and eight hours. Figure 2 shows the percentage of dose recovered from the liver, kidneys, spleen, and pancreas. It will be noted that the range for the liver was 84.8 to 88.5 per cent, a slight drop at the four-hour interval being the only significant time alteration in respect to this organ. For the kidneys the range of percentages was 4.2 to 7.4 per cent, with a definite rise at the four-hour interval. For the spleen the range was

2.0 to 4.4 per cent, with slight rises at four and eight hours. For the pancreas the range was 3.2 to 4.7 per cent, with a rise at the six-hour interval.

Table I shows the results in relation to microcuries per gram of organ weight, and this correlates well with the percentage recovery in the liver and pancreas.

TABLE I: AVERAGE MICROCURIES OF ZINC 65 PER GRAM IN THE LIVER, SPLEEN, PANCREAS, AND KIDNEY AT TWO-, FOUR-, SIX-, AND EIGHT-HOUR INTERVALS AFTER ADMINISTRATION (2 DOGS AT EACH INTERVAL)

	2 Hr.	4 Hr.	6 Hr.	8 Hr.
Liver	0.246	0.172	0.250	0.148
Spleen	0.056	0.027	0.048	0.031
Pancreas	0.113	0.093	0.218	0.155
Kidney	0.118	0.087	0.108	0.062

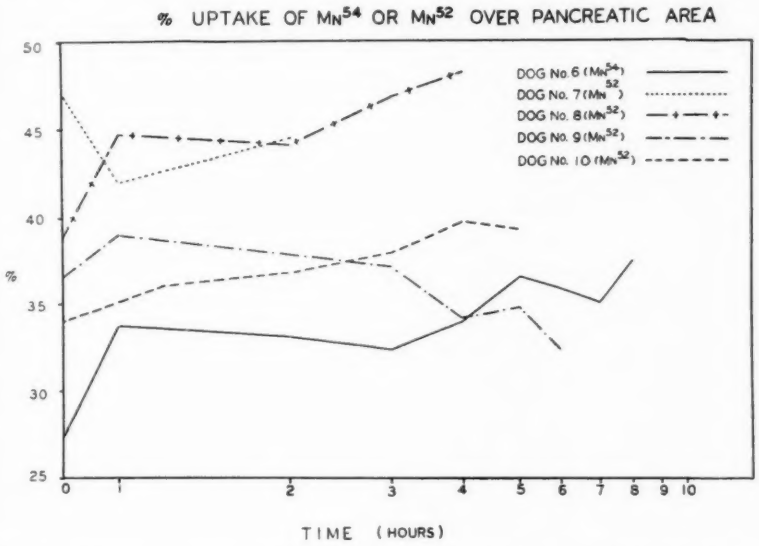


Fig. 3. Percentage uptake of manganese 54 over pancreatic area in dogs 1–5 (study extended up to two hundred hours).

The specific activity for the pancreas was highest at six hours, with slight drops at the four- and eight-hour intervals. For the liver the specific activity was approximately the same as that of the pancreas at the six-hour interval, also with a slight drop at four and eight hours. The concentrations were less in the spleen and kidneys and did not parallel the percentages of total recovered zinc 65 from these organs.

In general, the results obtained in the zinc 65 chloride experiments were closely paralleled by those with zinc 65 sulfadiazine and zinc 65 complex of 3′- or 6′-aminofluorescein.

Manganese Compounds: The uptake and radioassay data for manganese are summarized in Figures 3, 4, and 5. It is seen that on the average the uptake as measured externally over the pancreas diminished to a minimum at the three- to four-hour interval and rose to a maximum at the six-hour interval. This curve, however, was not absolute in each case. The radioassay data revealed the following:

1. The relative concentration in the liver gradually increased to its first maximum at 6 hours, diminished somewhat at the twenty-four-hour interval, and thereafter increased to another maximum at seven days.

2. The relative concentration in the kidney, pancreas, and spleen diminished progressively for the first six hours and increased rapidly thereafter to the eight-hour interval. At twenty-four hours the kidney concentration was maximum, diminishing thereafter for seven days.

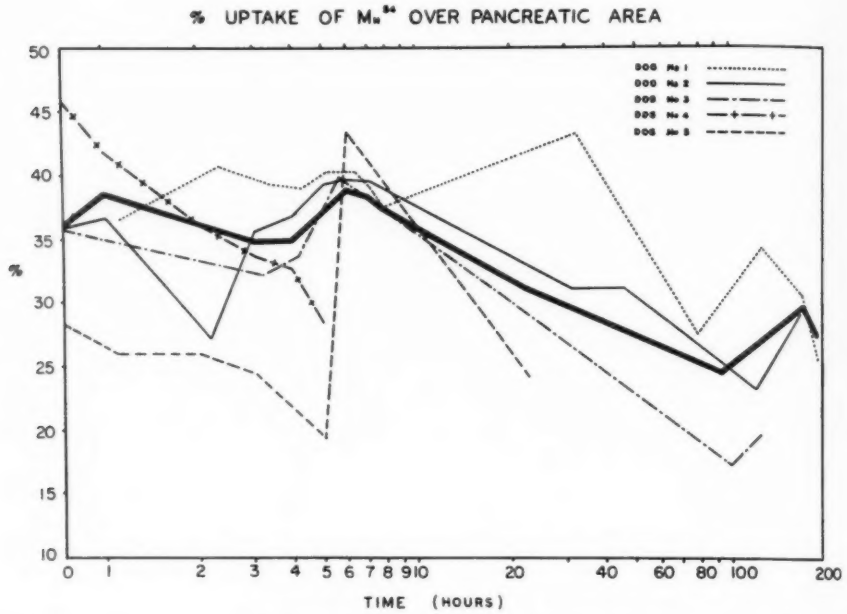


Fig. 4. Percentage uptake of manganese 54 or manganese 52 over the pancreatic area in dogs 6–10 (study extended up to eight hours).

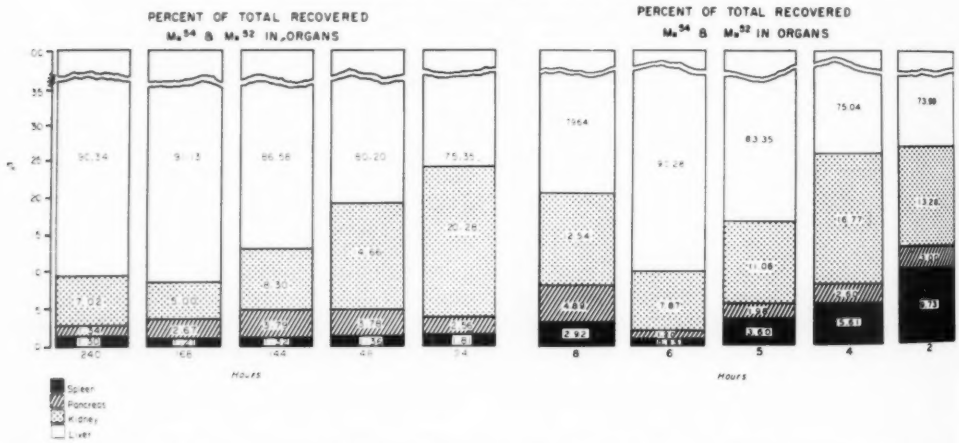


Fig. 5. Percentage of total recovered manganese 54 or manganese 52 in spleen, pancreas, kidney, and liver (two to two hundred and forty hours).

3. The pancreas and spleen showed maximum concentration relatively at the eight-hour interval.

Gross autoradiographic data (Fig. 6) tend to corroborate the above results. Grossly, in the kidney, concentration was maximum in the cortex. There was no selective concentration otherwise within other organs studied.

The microcurie concentration of manganese, per gram weight of organ (Table II), showed a gradual diminution with low-level concentration at six hours. There was a rapid parallel rise in the liver, pancreas, and kidneys by the eighth hour, no significant change at twenty-four hours, and a further gradual rise by the forty-eighth hour. With the exception of the

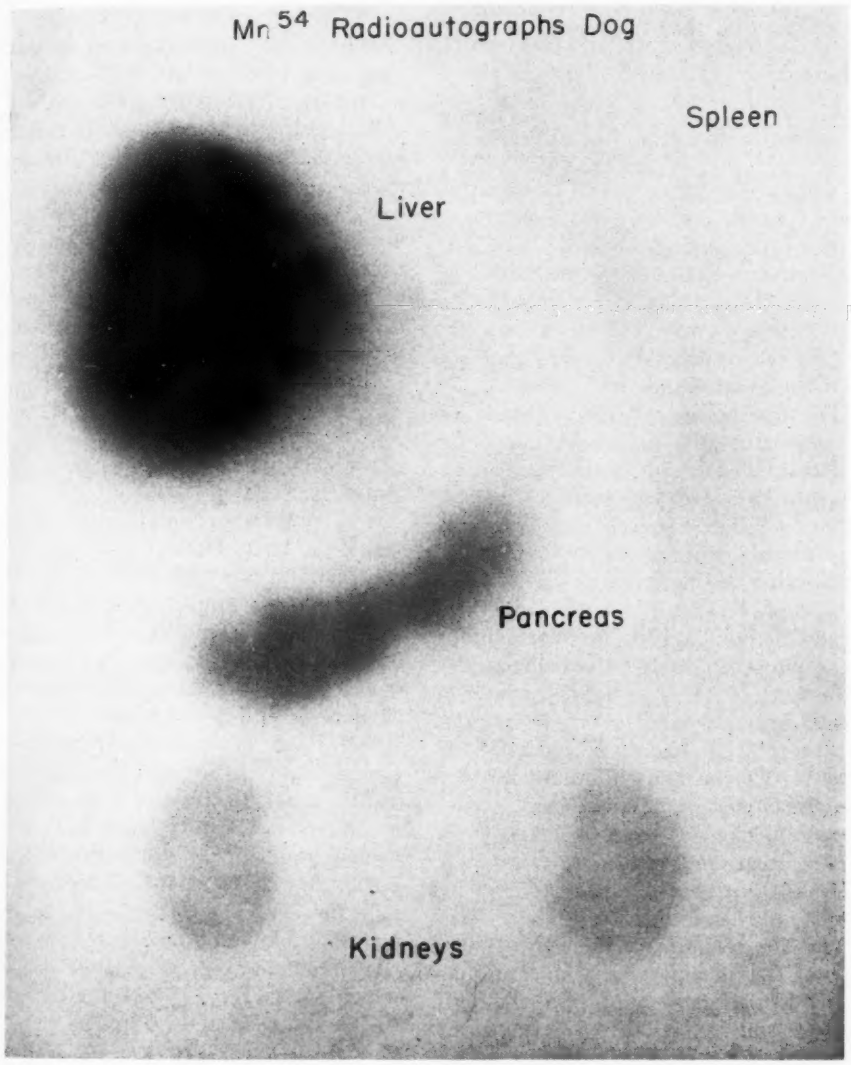


Fig. 6. Representative gross autoradiographs of the liver, spleen, pancreas, and kidneys following intravenous injection of manganese 52 and 54.

TABLE II: MICROCURIES OF MANGANESE 54 AND 52 RECOVERED AT AUTOPSY FROM LIVER, SPLEEN, PANCREAS, AND KIDNEY AT VARIOUS INTERVALS

	2 Hr.	4 Hr.	5 Hr.	6 Hr.	8 Hr.	24 Hr.	48 Hr.	144 Hr.	168 Hr.	240 Hr
Liver	0.034	0.025	0.016	0.022	0.068	0.072	0.106	0.046	0.134	0.059
Spleen	0.018	0.009	0.004	0.002	0.004	0.016	0.010	0.004	0.007	0.005
Pancreas	0.014	0.012	0.008	0.007	0.042	0.034	0.076	0.030	0.050	0.021
Kidney	0.037	0.040	0.024	0.020	0.054	0.050	0.110	0.033	0.044	0.038

six-day animals, there was thereafter a gradual diminution in the pancreas and kidney with a slight rise at first in the liver and, subsequent to this, a gradual fall.

Once again these curves would suggest a critical metabolic alteration occurring be-

tween four and eight hours. The peak rise in the spleen is at twenty-four hours, and there is a gradual diminution thereafter.

DISCUSSION

The above results would suggest a biphasic type of curve for both zinc and manganese compounds when "uptake" over the pancreatic area is recorded. There would appear to be a concavity in the two- to four-hour interval in this uptake curve. The results with the zinc 65 sulfadiazine and zinc 65 complex of 3′- or 6′-aminofluorescein closely resembled those with zinc 65. Also the curve for zinc resembled somewhat the manganese curve, but showed a greater specific activity for the pancreas. There are various factors which one must consider in interpreting these curves:

It is probable that the uptake curve as recorded, although obtained principally over the pancreas, includes a considerable contribution from the liver, since the liver and pancreas concentrations parallel each other closely and it is virtually impossible for the uptake collimator to view the pancreas without encompassing some liver component.

The scanogram studies are not sufficiently detailed to be applicable either clinically or experimentally. In part this may be related to the fact that a crystal of insufficient size was employed to absorb a significant number of the high-energy gamma radiations. We have now obtained a 3 × 3-inch sodium iodide thallium-activated crystal in an attempt to see whether these scanner studies cannot be improved. Our preliminary results are no better.

Possible future applications of the above data to human study will depend upon the following:

1. Specific "blocking" or "flushing" agents which might diminish relative liver concentration of the isotope. In this connection it might be related that experiments employing bromsulphalein and British anti-lewisite (BAL) were ineffective in this respect. In any case, specific "flushing" or "blocking" agents should be sought in an effort to diminish the relative liver concentration of the isotope.

2. Development of suitable radioisotope scanner equipment to scan the pancreas more selectively with permissible doses of zinc 65. From presently available unpublished data (13) it appears probable that the maximum permissible tracer dose of zinc 65 in the average person is 61 microcuries when administered intravenously with the total body as the "critical organ."

3. Development of improved specificity for the pancreas by combining zinc with other organic compounds, possibly manganese as well.

4. From our present point of view it would appear that zinc and/or iodine compounds may be most useful only if the iodine can be retained in the complex molecules so produced. Ordinarily iodine is broken away prior to its concentration in the pancreas and hence is not particularly useful in this respect.

We have not described here our few experiments in far advanced cancer patients, particularly with zinc. Thus far a complete uniformity has not been obtained and the uptake curve is therefore not particularly useful clinically. Efforts will be continued, however, to develop compounds which are more specific for the pancreas and to devise equipment which will be more specific for radiations of the energies emitted by zinc 65.

SUMMARY

External uptake measurements over the pancreas were made at intervals of eight to twenty-four hours in 15 dogs following the administration of zinc 65 chloride and in 2 additional dogs receiving zinc 65 sulfadiazine and zinc 65 complex of 3′- or 6′-aminofluorescein. These measurements were correlated with total organ concentration and concentration per gram weight in the liver, spleen, pancreas, and kidneys at various time intervals.

Similar data are presented in relation to

the uptake of manganese 54 and 52 over the pancreas in 10 dogs in two hours to ten days. These data are again correlated with per cent of total manganese recovered at similar time intervals from the liver, spleen, pancreas, and kidneys.

A biphasic curve was obtained representing organ concentrations in the liver and pancreas for both the zinc and the manganese. Thus far, however, this curve has not proved to be clinically useful.

Concentration of zinc 65 in the pancreas is greater than that of manganese 52 or 54, and is probably more suitable for pancreatic tracer studies.

Attempted isotopic scanograph studies for delineation of the pancreas were of no value with presently available apparatus.

ACKNOWLEDGMENTS: The authors are grateful for the numerous suggestions and constant help of Dr. David Cayer, Professor of Medicine and Chief of the Gastroenterology Section, Bowman Gray School of Medicine and North Carolina Baptist Hospital, Winston-Salem, N. C. Dr. Cayer helped initiate the project and contributed valuable guidance as problems arose in the course of the study.

For technical assistance we are indebted to C. A. Kimel, Samuel S. Lam, Charles B. Maynard, and Frank B. Sellers.

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SUMMARIO IN INTERLINGUA

Le Utilisation de Zinc e Manganese Radioactive in un Effortio de Visualisar le Pancreas

Externe mesurationes del acceptation esseva facite supra le pancreas, a intervallos de inter octo e vinti-quatro horas, in 15 canes subjicite al administration de chloruro de zinc-65 e in 2 canes additional subjicite al administration de sulfadiazina a zinc-65 e de complexo a zinc-65 de 3'- o de 6'-aminofluoresceina. Iste mesurationes esseva correlationate con le concentrationes in organos total e in unitates de peso de un gramma de hepate, splen, pancreas, e ren a varie intervallos de tempore.

Simile datos es presentate con respecto al acceptation de manganese-54 e manganese-52 supra le pancreas de 10 canes in inter duo e dece dies. Iste datos esseva equalmente correlationate con le procentage recovrate del manganese total a simile intervallos ab hepate, splen, pancreas, e ren.

Un curva biphasic esseva obtenite como

representation del concentrationes de organo total in hepate e pancreas, tanto in le caso de zinc como etiam in le caso de manganese. Tamen, usque nunc le curva ha non essite de utilitate clinic.

Zinc-65 monstra plus alte concentrationes in le pancreas que manganese-52 o manganese-54 e es probabilemente plus appropriate pro studios pancreatic a traciator que le duo altere isotopos.

Studios isotopic a scanographo, interprendite pro delinear le pancreas, esseva sin valor con le apparaturas que es currentemente disponsibile.

Villous Adenoma of the Sigmoid Colon[1]

THOMAS R. FRYE, M.D.

VILLOUS ADENOMA of the colon is a somewhat rare benign tumor which has remained unmentioned in the radiological literature. Such a lesion was recently studied in our department and we believe that the history and the unusual roentgenologic manifestations may well be characteristic of this interesting neoplasm.

Incidence: These tumors are encountered largely in the later decades, the average age of incidence being in the midfifties, with no apparent familial or sexual tendency. They occur singly and have been stated to constitute from 0.1 to 6.6 per cent of all rectal and sigmoid lesions (10). In one series of 1,144 tumors of the colon and rectum, villous adenomas were said to represent 2.3 per cent of the total (2).

Pathology: The term "villous tumor" was originated by Holmes, a British pathologist, in 1860. At various times, and by various authors, these neoplasms have been called papillomas, mucous or columnar papillomas, villous papillomas, papillary polyps or adenomas, villous adenomas, and villomas. The usual site of occurrence is in the colon, primarily in the rectum and sigmoid, where approximately 80 per cent of the tumors are found (13). Similar lesions have been described in the stomach and gallbladder.

The benign epithelial tumors of the colonic mucosa have been divided into two categories, the villous adenoma and the adenomatous polyp. The adenomatous polyp is typically a compact, spheroid, pedunculated mass; the villous adenoma is a soft, sessile tumor without a pedicle. The adenomatous polyp is said to occur in about 7 per cent of all adults, while the villous adenoma is relatively rare.

Grossly the villous adenoma ranges in size from a nodule several centimeters in diameter to a mass of enormous size, completely encircling the bowel. The tumor is spongy, red or red-gray in color, and usually sessile, with a broad flat base. It is extremely soft and velvety and is made up of a large number of friable villi or finger-like projections joined at their bases in a pattern which is frequently lobulated. The entire lesion is usually covered by thick, viscid mucus. Occasionally the tumor appears pedunculated; this is felt to be due to stretching of the redundant surrounding mucosa by the weight of the mass.

Microscopically the surface is made up of multiple tiny villi covered by a layer of columnar cells in a close, almost normal, relationship with the muscularis mucosa. The connective tissue of the submucosa is edematous and highly vascular. In typically benign lesions there is no involvement of the deeper layers. However, there is said to be a strong tendency toward invasion and malignant transformation.

Symptoms: The most prominent and characteristic symptom is the profuse discharge of large amounts of mucus produced by the tumor. In some instances this has led to the erroneous diagnosis of "mucous colitis." The mucus is usually passed separately from the normally formed stool. In at least 2 cases from the literature (6, 7), as well as the one to be reported here, the passage of enormous amounts of mucus has led to extreme dehydration and electrolyte imbalance. Another prominent finding is rectal bleeding, due to the vascularity and friability of the tumor tissue. Less frequent symptoms are altered bowel habits, tenesmus, a sensation of incomplete evacuation, evidence of partial obstruction, and occasionally the actual protrusion of tumor tissue from a low-lying lesion. In one series (2) the average duration of symptoms

[1] From the Radiology Department, Ohio State University Health Center, Columbus, Ohio. Accepted for publication in September 1958.

was fifteen months, but a small percentage of patients are symptom-free.

Diagnosis: The appearance in a barium enema examination, we believe, may well be characteristic for this neoplasm. The barium-filled colon shows a sharply demarcated mass extending into which are thin linear streaks of barium resulting from the insinuation of the liquid barium between the folds and villi of the tumor. A large portion of the mass is probably due to collected mucus. Following evacuation, the tumor appears to be reduced in size, with evidence of a rough, serrated, feathery margin. The history of frequent passage of mucous stools separated from the normal stools, rectal bleeding, and a mass in the distal colon are suggestive of a villous adenoma. The tumors have often been overlooked on digital examination because of their softness and lack of induration. If the lesion can be visualized sigmoidoscopically, a large, soft, red-gray mass made up of villous fronds that float and wave freely in the covering mucus can be seen.

CASE REPORT

D. W. Y., a 63-year-old white male, was admitted to the University Hospital on March 29, 1958, complaining of anorexia, nausea, vomiting, and weakness. His illness began about one year prior to admission, when he noticed the passage of mucus, distinctly separate from the stool. The frequency and quantity of mucoid material had increased during the interval with an accompanying weight loss of 15 to 20 pounds. At the time of admission the patient was passing one half to one cup of mucus five to ten times daily, resulting in dehydration and electrolyte imbalance which had twice required hospitalization elsewhere for fluid and electrolyte therapy. There had been no bleeding, diarrhea, or pain. The patient had undergone a Billroth I hemigastrectomy and vagotomy for duodenal ulcer five years prior to admission and a suprapubic prostatectomy two years prior to admission.

The patient appeared chronically ill but in no acute distress. The blood pressure was 140/85, pulse 80, respirations 16, temperature 99.4° F. rectally. A rectal mass was palpated digitally and was described as either redundant mucosa or a very soft tumor. At sigmoidoscopy 400 c.c. of mucus was aspirated, and a sharply demarcated, extensive, soft tumor with multiple friable villi was seen. The mass encircled the rectosigmoid, extending from about 7 cm. for a distance of approximately 8 cm. Multiple biopsies were obtained and reported by the pathologist as benign villous (papillary) adenoma.

Laboratory studies on admission showed a moderately severe hypokalemic alkalosis, with serum potassium 2.4 mEq., chloride 78 mEq., CO_2 92 volumes per cent, and blood urea nitrogen 23 mg. per cent. Analysis of the mucous discharge, which was passed in quantities of 1,000 to 2,000 c.c. per day, showed 114 mEq. per liter of sodium, 19 mEq. per liter of potassium, and 120 mEq. per liter of chlorides. Vigorous fluid and electrolyte replacement therapy resulted in clinical improvement and return of the laboratory findings to normal values.

Supine and upright films of the abdomen showed moderate distention of the colon, a few minimally dilated loops of small bowel, and very little gas in the rectum, findings which were attributed to a partial obstruction in the region of the rectosigmoid. Intravenous pyelograms were normal except for a large soft-tissue mass in the pelvis. A barium enema examination showed a large, sharply demarcated, circumferential lesion in the distal sigmoid through which the barium flowed with difficulty. Barium extended into the tumor in linear streaks, as it apparently insinuated itself between mucous-covered folds and villous strands of the mass (Fig. 1). The film following evacuation showed the lesion to be somewhat smaller, due probably to partial evacuation of the collected mucus, with the tumor outline displaying a rough serrated contour (Fig. 2).

Following blood volume replacement and bowel preparation, operation was performed. The tumor, which lay just above the peritoneal reflection, was mobilized, and an anterior resection carried out, with side-to-end anastomosis of the proximal sigmoid colon to the rectal stump. The postoperative course was uneventful except for some difficulty with urinary retention. The patient was discharged on the nineteenth postoperative day.

The pathological specimen was a 35-cm. segment of colon which, in its distal portion, showed a large papillary mass that extended 17 cm. longitudinally and encircled the bowel without anatomic obstruction (Figs. 3 and 4). The cut section showed mucosal proliferation of individual papillary fronds which measured 3 to 5 mm. in length and 0.5 to 1.0 mm. in diameter; the villous mucous membrane was thrown up in broad undulating folds which were freely movable over the muscular wall; the submucosa appeared normal. The microscopic diagnosis was villous (papillary) adenoma with primarily exophytic growth and abrupt transformation of normal mucosa to the villous pattern. There was no extension of the tumor beneath the mucosa and no evidence of malignant transformation in multiple sections studied.

DISCUSSION

The case presented is quite typical clinically of the large villous adenomas of

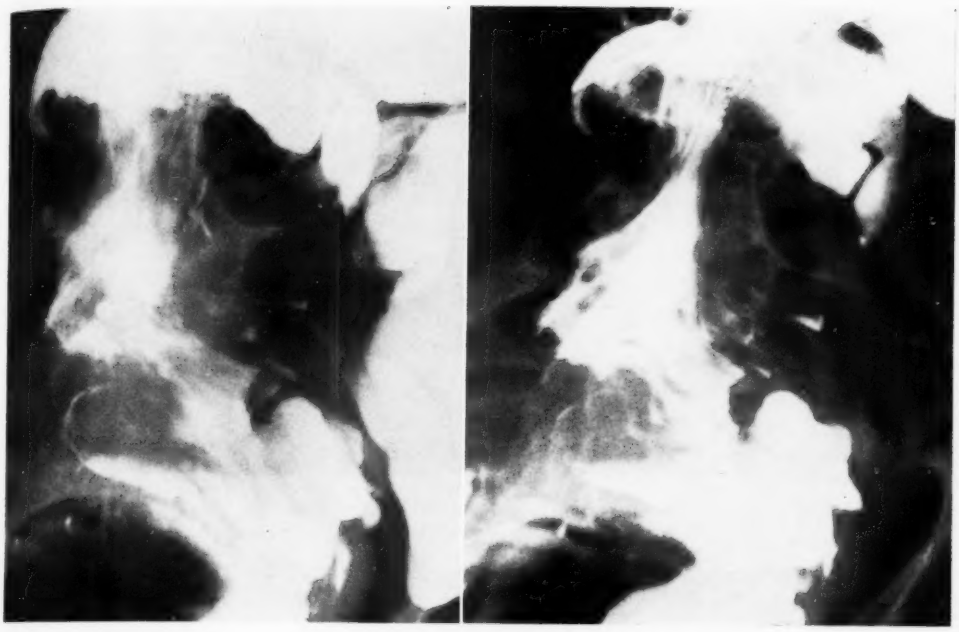

Fig. 1. Films of the sigmoid at barium enema examination, demonstrating the large tumor mass and linear streaks of barium extending into it.

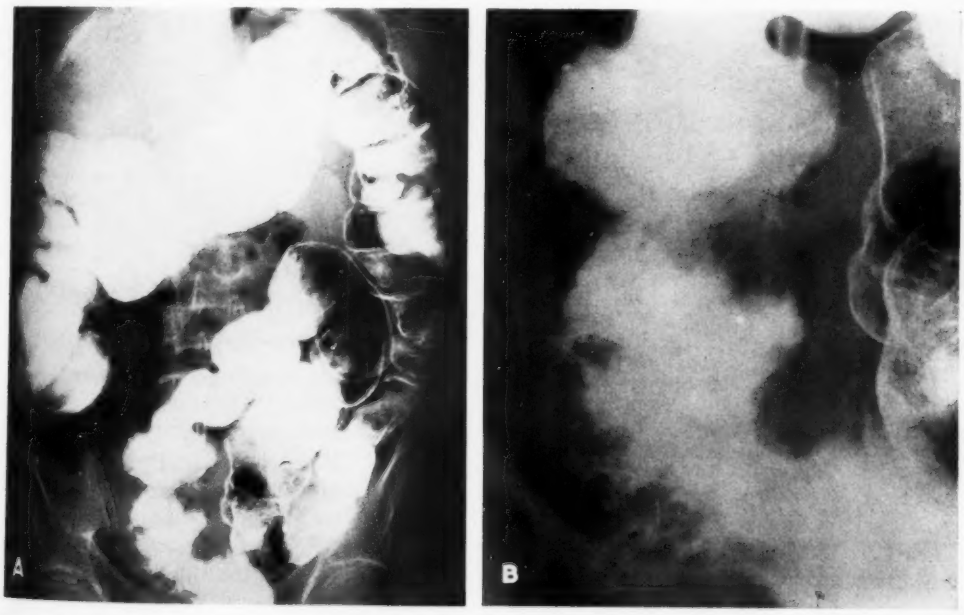

Fig. 2. A. Film following evacuation showing the area of involvement in the sigmoid. B. Enlargement of the sigmoid area showing the rough serrated outline of the tumor mass.

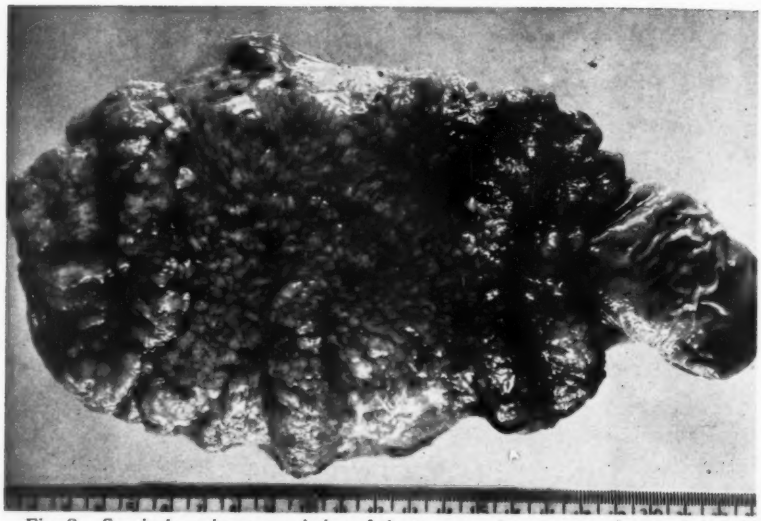

Fig. 3. Surgical specimen, consisting of the tumor and a segment of normal sigmoid colon (seen on the right), has been turned inside out to demonstrate the extent of the encircling lesion.

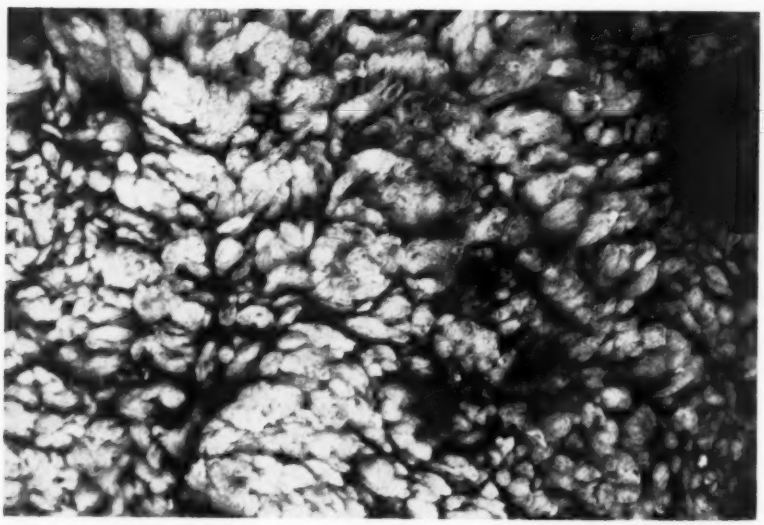

Fig. 4. Photograph (magnified) of the tumor taken with the specimen under water to demonstrate the villous nature of the epithelium.

the colon except for the absence of rectal bleeding. We believe that the roentgenologic finding of a large mass showing linear streaks of barium extending into it (between the folds and villi) on the filled enema films, and the rough feathery appearance of the margins of the tumor on the postevacuation film, may be characteristic. When these findings are present with the usual clinical story of profuse mucous discharge, rectal bleeding, and symptoms of a partially obstructing colon tumor, a nearly definitive diagnosis can be made. Furthermore, the marked electrolyte imbalance, dehydration, and decrease in weight due to the excessive loss

of the protein- and electrolyte-rich mucus are important associated findings.

An accurate preoperative diagnosis is most important to the surgeon, for while these lesions are said to be characteristically benign, various authors (3, 5) have stated that malignant transformation occurs in 20 to 100 per cent of the cases. The most widely accepted figures are from Sunderland and Binkley (11), who found malignant transformation in 68.7 per cent of their cases, 39.5 per cent being invasive carcinoma. It must be stressed that serial sections through the tumor are necessary for accurate evaluation. A marked tendency to recurrence after local removal has been noted, and adequate excision is therefore highly desirable. It is interesting to note that in one series (13) approximately one-third of the cases studied showed an additional benign or malignant tumor of the bowel.

SUMMARY

A report of a villous adenoma of the sigmoid colon has been presented emphasizing the roentgenologic and clinical findings in such lesions. It is suggested that the roentgenologic findings may well be characteristic for such a tumor. The benign origin of these tumors is described and the high incidence of malignant transformation is stressed. It is this that makes early diagnosis and adequate removal most important.

ACKNOWLEDGMENT: The author is grateful to Robert M. Zollinger, M.D., for permission to report this case and to Jacob Old, M.D., for the pathology material.

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SUMMARIO IN INTERLINGUA

Adenoma Villose del Colon Sigmoide

Es reportate un caso de adenoma villose del colon sigmoide. Attention special es prestate al aspecto roentgenographic que es considerate como characteristic. In le examine roentgenographic post clyster a barium le tumor se monstra como un massa con invasiones del barium in bandas linear inter le plicas mucose e le villos que forma le superficie. Le pellicula obtenite post le evacuation monstra un reduction del dimensiones del massa e un aspere margine del tumor con le delineation de un pluma. Le reduction del dimensiones del massa es probabilemente le effecto de un perdita de muco.

Le facto que iste tumores es originalmente benigne e que illos tende a transformar se in entitates maligne rende importantissime que illos es diagnosticate e excidite precocemente.

Clinical Experience with High-Speed Electrons in Cancer Therapy

ERICH M. UHLMANN, M.D., F.A.C.R.

THE UTILIZATION of high-speed electrons in the treatment of deep-seated malignant tumors which are not readily amenable to therapy with conventional sources of radiant energy has been advocated for many years (1). The installation of betatrons permitted, in addition to the use of x-ray beams, the application of electrons with energies up to 18 Mev for therapeutic purposes, although the range of penetration in this energy range is limited to 10 cm. (2, 3). To make the therapeutic application of electrons truly beneficial, sources with energy of 40 Mev or more are required. Betatrons with energies of 30–35 Mev have been constructed in Europe, but at present no clinical experience in this energy range has been published. The installation of a 45-Mev linear accelerator at the Tumor Clinic of Michael Reese Hospital provided us with a welcome opportunity to utilize high-speed electrons in the treatment of deep-seated malignant tumors.

Details as to the components and the functioning of the linear accelerator, which is a close adaptation of the apparatus developed in the Microwave Laboratory of Stanford University by Ginzton and others, were described two years ago (4). At the same time some physical characteristics of the apparatus and isodose curves were reported (5). Additional data on treatment planning have been published (6).

This presentation is concerned with the clinical application of electrons in the energy range between 20 and 40 Mev. The principal difference between high-speed electrons and x-rays in the multi-million-volt range lies in their depth penetration which, in the case of electrons, is sharply defined and mainly dependent upon the energy (Fig. 1). The penetration of the electrons in tissue expressed in centimeters can be obtained by dividing the energy by 2; however, the depth at which a therapeutically useful dosage is delivered is best estimated by dividing the energy by 3. This is demonstrated in Figure 2, which shows the depth-dose curves of beams in the energy range of 10 to 40 Mev. These curves were obtained from films sandwiched in unit density Presdwood with field sizes of 10 × 10 cm. The rapid decline of the radiation effects and the dependence of the depth penetration on the energy are obvious in these curves. A better insight into the actual dose distribution is demonstrated in the following three figures which show isodose curves obtained with identical field sizes of 10 × 10 cm. and energies of

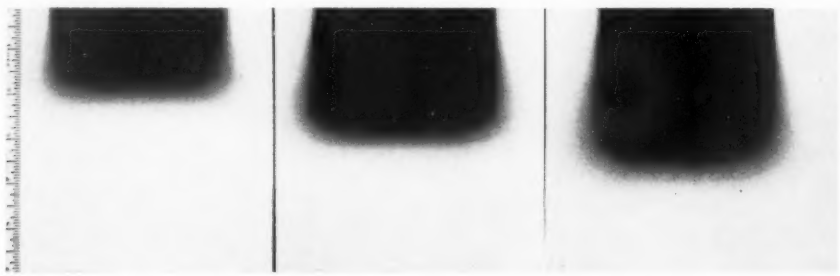
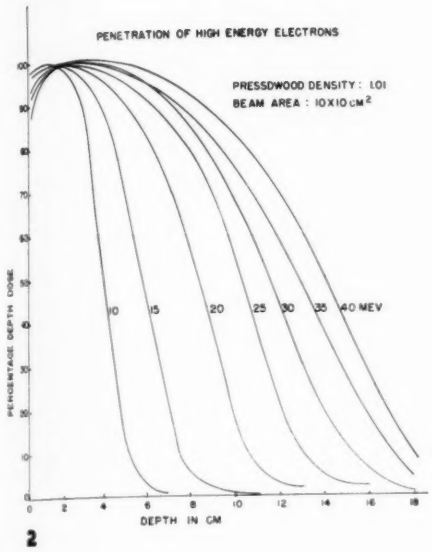
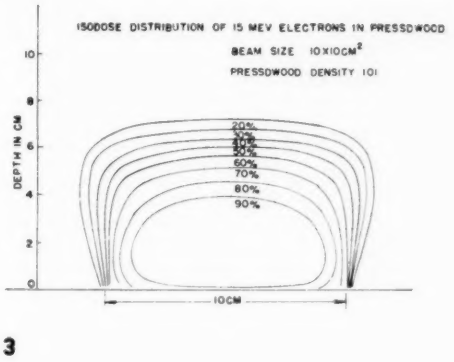
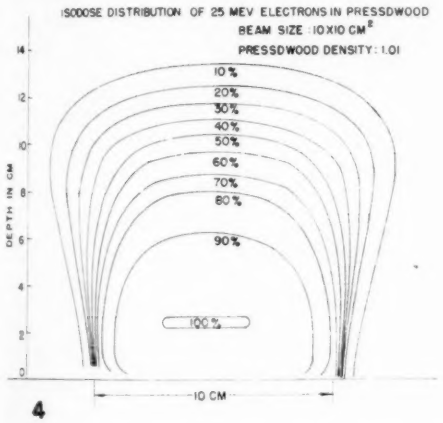


Fig. 1. Depth penetration of 10 Mev; 15 Mev; and 20 Mev electron beams.

[1] From the Tumor Clinic of Michael Reese Hospital Medical Center, Chicago, Ill. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16–21, 1958.







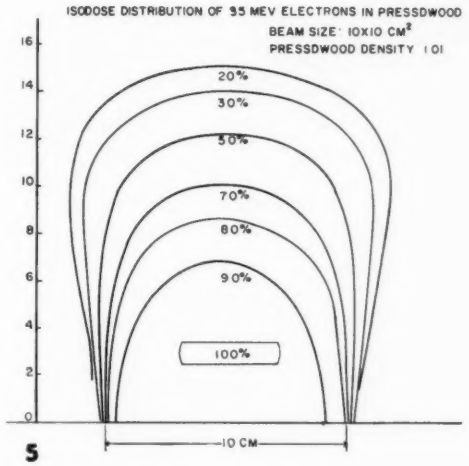


Fig. 2. Penetration of high-energy electrons in the energy range 10 to 40 Mev.
Figs. 3–5. Isodose curves for energies of 15, 25, and 35 Mev. Field size 10 × 10 cm.

15, 25, and 35 Mev respectively. At the depth of 10 cm. no radiation effects are present in the 15 Mev range, but 48 per cent is measured for 25 Mev and 70 per cent for 35 Mev. At 15 cm. depth the beams of 15 and 25 Mev are ineffective, and of the 35 Mev beam only 20 per cent is left. These isodose curves reveal the characteristics of single-field application and demonstrate their effectiveness in defined areas.

The treatment of a carcinoma of the tongue may serve as an example of their usefulness. In this instance (Fig. 6) a single field application (10 × 10 cm.) and an energy of 20 Mev was chosen. We realize that this type of neoplasm, which was localized 4 to 5 cm. below the lateral surface of the cheek, could have been successfully treated with other forms of radiant energy. We have accumulated considerable experience in treating such

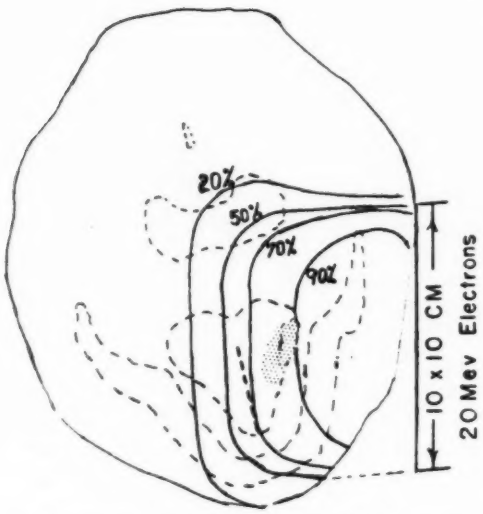


Fig. 6. Treatment plan for cancer of the tongue.

lesions with a combination of telecurietherapy and interstitial radium application and therefore thought it of interest to compare our results with electron therapy. Another, more impelling reason was the desire to observe and study the reactions of the skin as well as the mucous membrane for guidance in future therapy. A total dosage of 6,000 r was delivered to the surface of the skin and the same amount to the tumor, localized on the left lateral border of the tongue, with the result that the lesion disappeared completely and healed with a defect in the area of the original ulceration. The skin reaction was mild.

Important to us was the observation of the mucositis, which was limited to the left side of the tongue and sharply demarcated at the septum in the midline. On the surface of the tongue a yellow membrane appeared shortly after the termination of the course of therapy and disappeared completely within two weeks.

Another, more significant, application of single-field technic with high-speed electrons is shown in Figure 7. In this instance a solitary metastasis of an osteogenic sarcoma in the right lung was treated with a field size of 6 × 6 cm. and an energy of 30 Mev. The exact localization of the tumor was determined from tomographic studies. The local result after application of 6,500 r is shown; there was considerable regression of the metastatic tumor, with development of atelectasis. The patient died nine months later from metastases in the skeletal system and internal organs, for which he had not been subjected to treatment. The autopsy did not show any significant fibrosis in the treated lung area.

Although the single-field technic is efficient in the treatment of properly selected patients, the possibility of using angular or opposite fields is, in our opinion, an even more attractive feature of therapy with high-speed electrons. Figure 8 shows the shape of a homogeneously irradiated volume throughout a depth of 20.5 cm. approached from opposite sides with an energy of 25 Mev and a field size of 10 × 10 cm. The entire volume is irradiated with a dose of 95 per cent ±5 per cent. The shape of the fields, the maximum dosage concentration in the center, and the depth penetration can be easily changed by variations of energy and field sizes.

The accompanying figures show the application of these principles in the treatment of carcinomas of the urinary bladder, the esophagus, and the nasopharynx in specific instances.

In the urinary bladder we were faced with the problem of treating a squamous-cell carcinoma which had been subjected to repeated transurethral resections and, at the time of our first consultation, involved more than one-half of the bladder. The anteroposterior diameter of the patient measured 20 cm., and an energy of 33 Mev was selected in planning the therapy. Two adjacent fields of 8 × 15 cm. each were used anteriorly and posteriorly to cover the tumor throughout its extent, which was estimated from cystograms and bimanual examination as approximately 4 × 5 × 8 cm. Figure 9 shows the dose distribution whereby 6,500 r were delivered to the tumor, with a narrow central area receiving

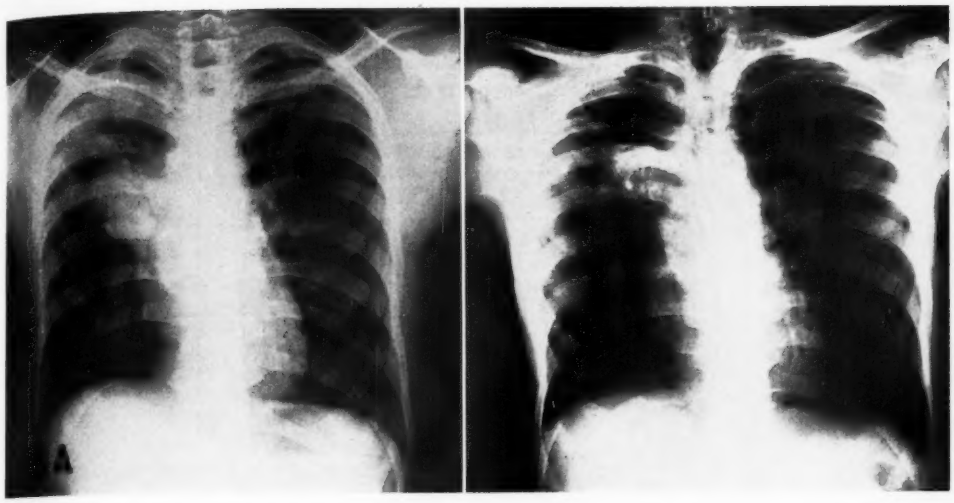


Fig. 7. Pulmonary metastasis from osteogenic sarcoma. Treatment at 30 Mev (field 6 × 6 cm.) for a dose of 6,500 r. A. Before treatment. B. After treatment.

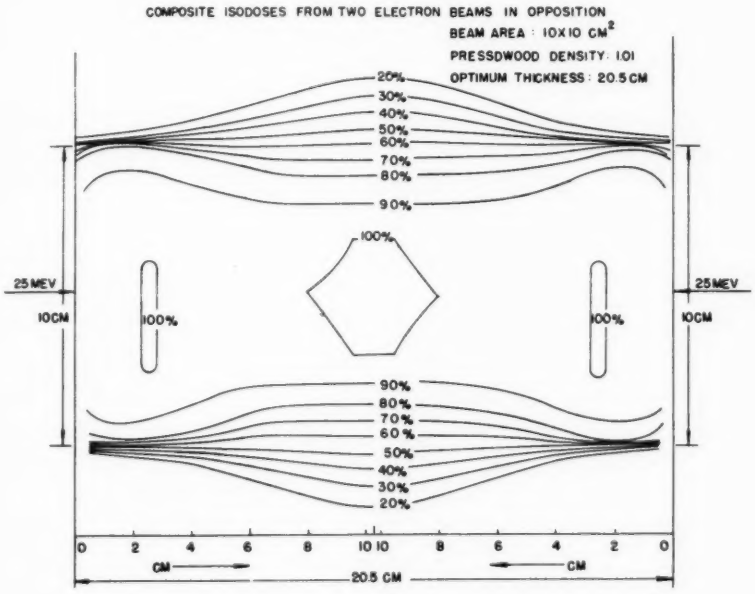
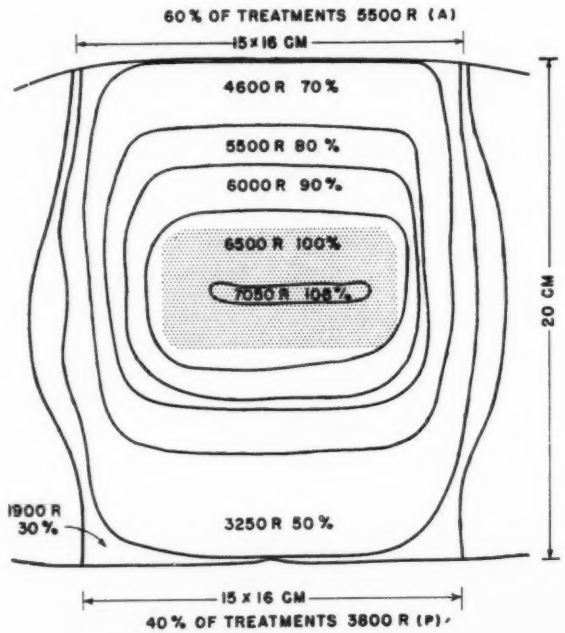


Fig. 8. Homogeneously irradiated area throughout 20 cm. depth.

more than 7,000 r. This was achieved by applying about 70 per cent of the depth dose (4,600 r) to the skin of the suprapubic area and 50 per cent (3,250 r) to the posterior fields in 37 treatments over a period of almost seven weeks. The skin reactions were mild. The cystograms before and after treatment are shown in Figure 9, A and B. The patient is clinically well five months after therapy; a recent cystoscopy revealed no obvious tumor masses, and biopsy was therefore deferred.

Figure 10 shows the treatment plan



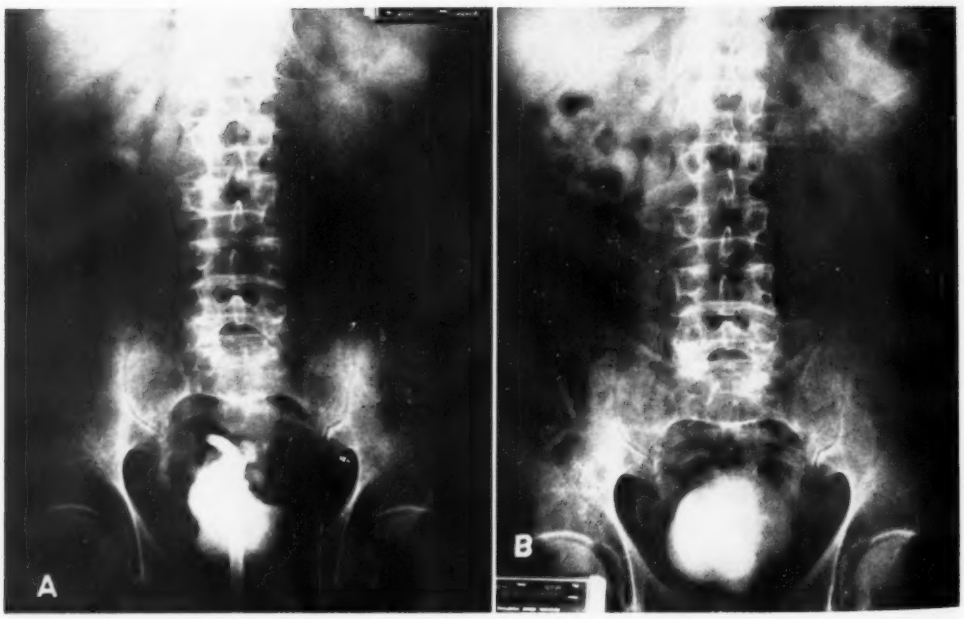
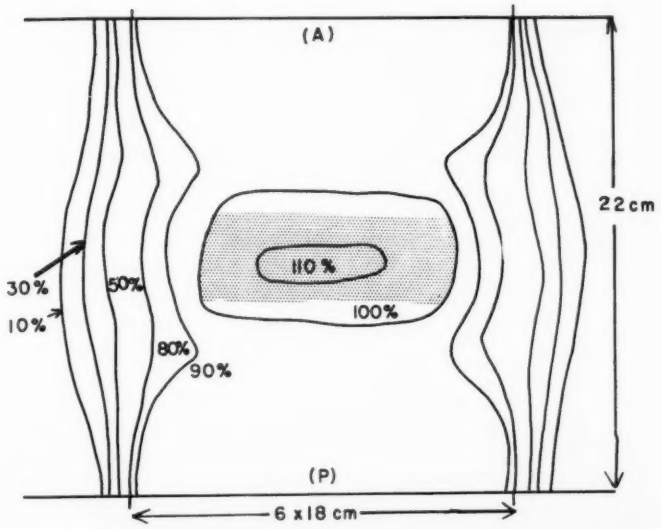


Fig. 9. Treatment plan for carcinoma of the bladder, with cystograms before (A) and after (B) irradiation.

for a squamous-cell carcinoma of the esophagus with an intrinsic mass extending over approximately 12 cm. in the upper and middle third of the organ. The patient was unable to swallow anything but fluids, and these only with difficulty;



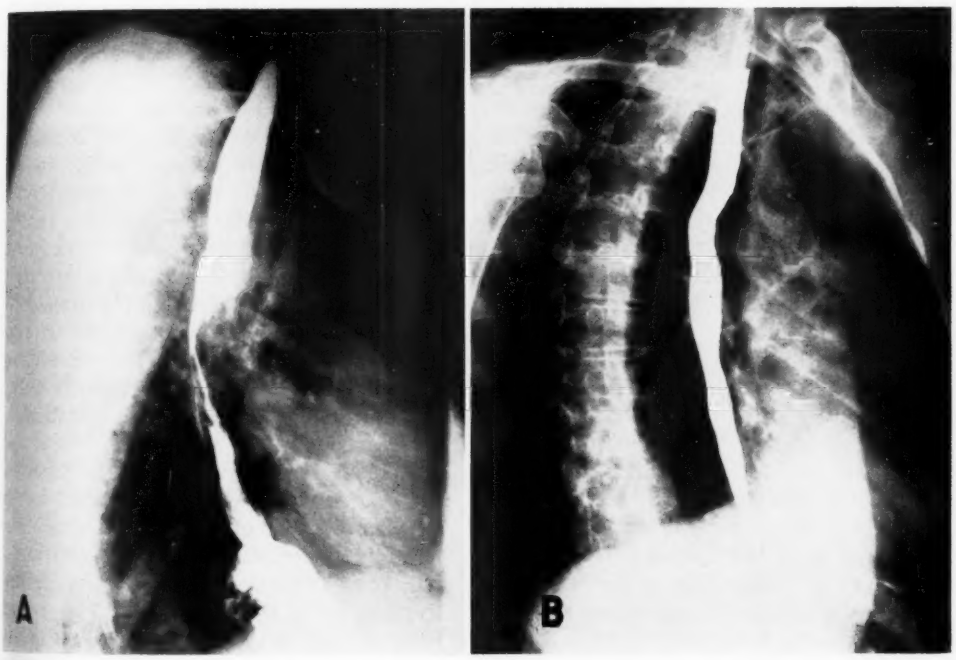


Fig. 10. Treatment plan for carcinoma of the esophagus, with roentgenograms showing results of irradiation. A. Before treatment. B. After treatment

the tumor was considered to be inoperable. Two opposite fields measuring 6 × 18 cm. to cover the entire tumor were chosen for treatment with an energy of 30 Mev. A total of 6,000 r was given to the tumor, with 4,075 r to the anterior and 4,370 r to the posterior field over a period of five weeks. The skin reactions were mild and cleared up completely within three weeks. The results of the treatment are demon-

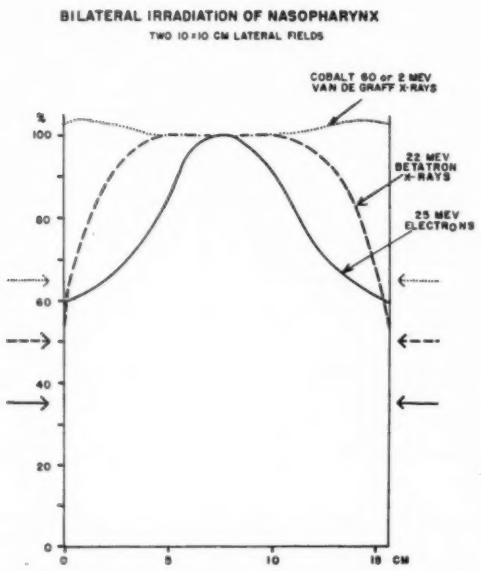


Fig. 11. Treatment plan for bilateral irradiation of a malignant tumor of nasopharynx.

strated in Figure 10, A and B. Clinically, the patient has been well for seven months and has regained all the weight lost during the year preceding therapy. Esophagoscopy was repeated, and biopsies were taken from the narrowed region as well as of areas below this portion of the esophagus; these examinations failed to reveal any signs of neoplasm, macroscopically or microscopically.

Figure 11 shows the treatment plan for a malignant chordoma of the nasopharynx. In this example, where the distance between the two lateral fields is just above 15 cm., the effectiveness of electron beams becomes quite apparent, especially when compared with irradiation produced with an energy of 2 Mev from a Van de Graaff machine, a cobalt-60 source, or x-rays of 22 Mev from a betatron. With 2 Mev an amount of radiation in excess of the tumor dose has to be delivered to both lateral fields in order to achieve an adequate dose distribution. Actually, the extent of the irradiated area is larger than required for therapeutic purposes. X-rays from the 22-Mev betatron permit a build-up of the dose in the tumor area with only 50 to 60 per cent on the skin, but again the volume of the tissue irradiated is more than necessary for adequate treatment of the tumor. Electrons applied through two fields of 8 × 10 cm. with an energy of 25 Mev permitted us to apply a tumor dose of 6,500 r in a limited area in the midline of the skull, adequate for therapy and with only 60 per cent of the tumor dose on the skin. The decline from the maximum in the central area is considerably steeper for electrons than for x-rays in a comparable energy range. The skin reactions following treatment were mild and cleared up completely within three weeks. The patient has remained well over an observation period of nine months.

These examples of clinical experience with electron therapy, accumulated during a relatively short time, are presented with the expectation that they will be repeated and multiplied in the treatment of malignant tumors which would otherwise offer little or no hope of control or palliation. An important factor in the utilization of high-speed electrons is the relatively small volume of tissue that is subjected to irradiation, even if the tumor is deep-seated. This factor alone may account for the absence of systemic reactions such as radiation sickness, decrease of the white blood cells, etc., making it possible to carry out treatment on an ambulatory basis unless hospitalization is required for other reasons.

No long-term survivals can be reported. One of our first patients treated for an adenocarcinoma of the uterus is well and without symptoms more than two and a half years after therapy. The first patient treated in a similar manner, as shown here, for an inoperable carcinoma of the esophagus, which already had produced a lymph-node metastasis in the left supraclavicular fossa, has lived without symptoms referable to the neoplasm for twenty-two months and has gained 35 pound. In many instances, treatments which had been started during the year 1956 and the first half of 1957 with apparently excel-

lent initial response had to be interrupted and eventually abandoned because of instrumental difficulties which forced us to discontinue operation of the accelerator for days and, occasionally, for longer periods. These adversities, which are unavoidable in the attempt to convert a research tool into an instrument suitable for the demands of continued clinical use, have been overcome. The linear accelerator has been in uninterrupted operation now for a full year, running six to eight hours daily and occasionally longer. On the basis of the experience gained during this last year, we are hopeful that the continuation of this work will yield further beneficial results and contribute to the improvement of cancer therapy.

ACKNOWLEDGMENT: The loyal co-operation of Edwin I. Hirsh, M.D., Jacques Ovadia, Ph.D., and Mr. John Duplex was instrumental in carrying out this work and is sincerely appreciated.

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Chicago 16, Ill.

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SUMMARIO IN INTERLINGUA

Experientia Clinic con Electrones de Grande Velocitate in le Therapia de Cancere

Iste articulo es concernite con le application clinic de electrones in le gamma de energia inter 20 e 40 milliones electron-volt. Le observationes esseva rendite possibile per le installation de un accelerator linear de 45 Mev in le Clinica Tumorologic del Hospital Michael Reese a Chicago.

Le differentia principal inter electrones de grande velocitate e radios X in le gamma de multiple milliones de volt jace in le profundor del penetration. In le caso de electrones, ille profundor es nettemente definite e depende primarimente del energia. Es presentate curvas de isodosage pro 15, 25, e 35 Mev que servi a demonstrar le efficacia del therapia a electrones in iste gamma. Es citate duo casos de tractamento a campo unic. Le un es un carcinoma del lingua, le altere un metastase pulmonar ab un sarcoma osteogene. Ancora plus interessante—in le opinion del autor—es le possibilitate del uso de campos opposite o angular. Exemplos del uso de iste technica es etiam presentate.

Un importante factor in le utilisation de electrones de grande velocitate es le relativemente micre volumine de histos que es exponite al irradiation, mesmo si le sito del tumor es profunde. Iste factor sol suffice possibilemente pro explicar le absentia de reactiones systemic, un facto que rende possibile le effectuation del therapia con le patiente in condition ambulante.

DISCUSSION

Roger A. Harvey, M.D. (Chicago): It is a pleasure and a privilege to discuss these two interesting and valuable papers.[1] I had the opportunity of seeing both of these machines in operation shortly before their application to patients. On the basis of my own experience in administering the harnessing and adapting of a somewhat lesser megavoltage monster, the betatron, to biological work I sympathetically and admiringly salute these authors and their associates.

I would seriously question the advisability of post-treatment biopsies, particularly in the esophagus, as mentioned by Dr. Uhlmann. I vividly recall my late associate, Dr. Lewis Haas, coming to me

[1] The other paper, by Dr. Robert S. Stone, on 70-Mev Radiation Therapy is to appear later, with the pertinent discussion.

and insisting that I do something about those people who continually stick aspiration needles or biopsy forceps into our treated patients. We saw enough local necroses and even perforations at these biopsy sites, demonstrated at ensuing autopsies, to make us firm believers in a wait-and-see attitude, especially in patients who had no gross demonstrable evidence of residual tumor, or who had not yet obtained the full effect from treatment.

The demonstrated possibilities of using opposing or near-opposing ports in this higher-energied electron-beam therapy in any area of a patient increases flexibility of treatment planning. We have used this technic to a limited degree, but our lower energy restricts us to head, neck, or extremities. I would question the use of only anterior and posterior opposing ports as demonstrated in the esophagus case. This arrangement delivers so large a dose to the spinal cord that a transverse myelitis is a real threat. Since there is energy to spare, I would prefer splitting the posterior field into two parts, moving off the midline, and angling medially so that the beams miss most of the spine and cross the esophagus.

It has been suggested that I mention something about our present program with the betatron. We continue with the use of the electron beam in patients. This beam is easier to use, is a little safer when one is regrouping with new personnel because one can "see" what is going on in the treated area, and finally is cheaper for us during a rather critical budget phase. In closing I would like to draw your attention to the potential problem one faces in the operation of these machines when they gradually outlive their compelling basic research attractiveness and become primary instruments for routine patient treatments. It is then that one feels the impact of the cost of replacement parts, particularly tubes, and the caliber of operator needed, *i.e.*, somewhere between an x-ray technician and a graduate physicist. These problems are very real in an institution which makes no patient charges, collects no insurance, has no endowment, and must compete with everyone else's newer ideas for tax dollars.

A Simplified Method of Treatment Planning[1]

LUCILLE A. DU SAULT

COMPOSITE ISODOSE curves for a combination of fields give the most complete information about dose distribution. The length of time consumed in constructing such curves for each plan to be considered in treatment of a patient is, however, prohibitive. Precalculated plans can be made up which can be tested in a minimum of time for applicability to a given patient by laying them over his contour tracing. These are simple to construct, and their accuracy is satisfactory. Residents using them soon acquire an understanding of the effect of field arrangement on dose distribution. They have been in use in the Department of Radiology of The Henry Ford Hospital (Detroit, Mich.) for a number of years and have been found practical.

In the early days of x-ray therapy the chief problem in treatment planning was to arrange the fields in such a way that skin tolerance would not be exceeded in delivering a cancerocidal dose to the tumor. It was thus natural that a system of dosage calculation based on skin dose should be developed. The use of compression cones to increase the depth dose meant that the skin was always at the same distance from the target of the x-ray tube. Thus, isodose curves used in treatment planning were made in terms of 100 per cent dose to the skin, or in air at the position of the skin, and for a fixed target-skin distance.

As higher energy sources became available, the same type of curve was made, modified only by shifting the 100 per cent value to the area of maximum dose below the skin surface. This was largely a matter of following tradition since, with the greater depth doses resulting from the high energy, cones for compression were no longer needed and, in fact, were undesirable from the point of view of skin sparing. With their elimination, there is no necessity for keeping the skin at a fixed distance from the source of radiation. Furthermore, the limiting factor in dosage is no longer skin, but usually some other normal tissue lying in the section of the body under treatment. With the skin dose obviously well below tolerance, it is unnecessary even to calculate it, and to continue to base dosage figures on this value becomes pointless. The identity and location of the tissue substitute for skin as the normal tissue whose tolerance is of concern in treatment planning vary with the body section under treatment and it would be difficult to base dosage calculations on it. Tumor dose is the only common factor in all calculations and would seem to be the logical basis for a system of dosage calculation.

In rotation therapy, the only point fixed with respect to the source is the axis of rotation, and contact cones cannot be used since the source-skin distance is constantly varying. Fixed or adjustable diaphragms at some distance from the patient define the field size at the axis of rotation. The application of conventional isodose curves to the problem of dose calculation here was difficult, although methods were devised. Then, Johns *et al.* (2) introduced the concept of tumor-air ratio, in which the dose at a point in tissue on the axis of the beam is expressed in terms of the air dose at the same point. This greatly simplified the procedure of calculating the dose at the axis during rotation. The logical step of making isodose curves expressed in terms of tissue dose at the axis was taken by Braestrup and Mooney (1), who described their use in calculating the dose at any point in the plane of the central axis of the beam during rotation.

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[1] From the Department of Radiology, The Henry Ford Hospital, Detroit, Mich. Accepted for publication in September 1958.

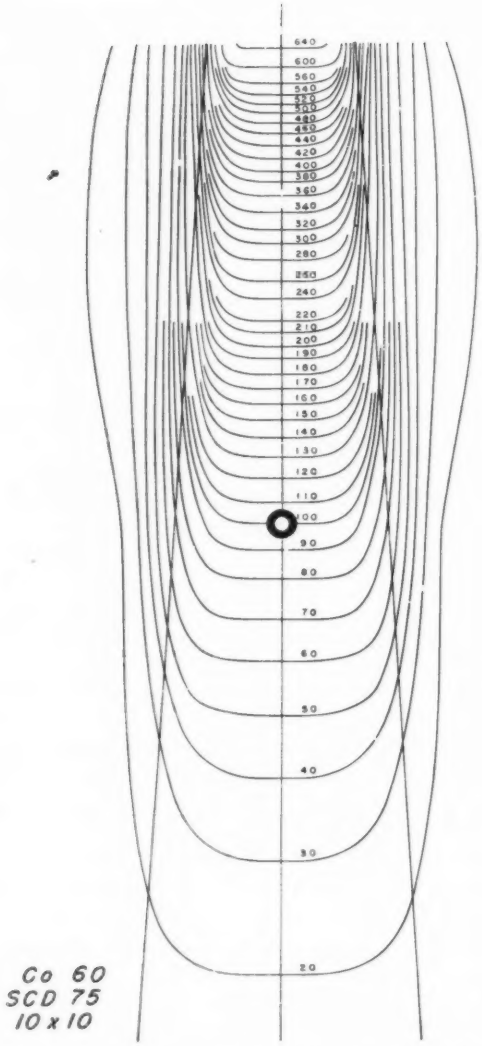


Fig. 1. Isodose curve based on 100 per cent at a depth in tissue.

Isodose curves of this type (Fig. 1) can be used equally well for stationary fields and offer certain advantages over the conventional type. With the latter, isodose lines resulting from various combinations of fields must be redetermined for every variation in patient size and contour. Any change in thickness of patient, for example, would change the separation between the surfaces of opposed fields, with a resultant change in dose distribution between them. The new type isodose curves extend indefinitely both above and below the 100 per cent point, which lies at a depth in tissue. They are independent of the surface. This means that isodose lines resulting from various combinations of fields, which will apply to any patient, may be made up in advance.

The method of making such isodose curves may be illustrated by taking the case of opposed fields for an example (Fig. 2). Two copies of the isodose curves are needed. These are superimposed in the positions which would be occupied by opposed beams, that is, from opposite directions on a common central axis and with the 100 per cent points coinciding. With 100 per cent contributed by each field, the dose at the central point will now be 200 per cent. At the point where the 110 per cent isodose line from one field intersects the 90 per cent isodose line from the other field the dose will also be 200 per cent, and similarly for 120 per cent and 80 per cent, etc. A line joining these points represents the 200 per cent isodose line for the combined fields. Other isodose lines are found in the same way. If the two sets of isodose curves are made in different colors it will be easier to identify them when they are superimposed. Examples of isodose lines obtained in this way are shown in Figure 3. It will be found easier to compare treatment plans if these are always reduced to 100 per cent at the center. While it is not necessary to have the centers of all fields coincide, it is simpler to make up the plans in this way, and is usually satisfactory as a treatment plan.

When a treatment plan for a patient is to be selected from among these, the contour is taken and transferred to tracing paper, the region to be treated is outlined, and normal structures whose tolerance must be considered are indicated, following the usual procedure. This tracing is laid over various plans in turn and its position shifted to find the best location for the center and the best pathways for the beams. A dozen plans, varying in such

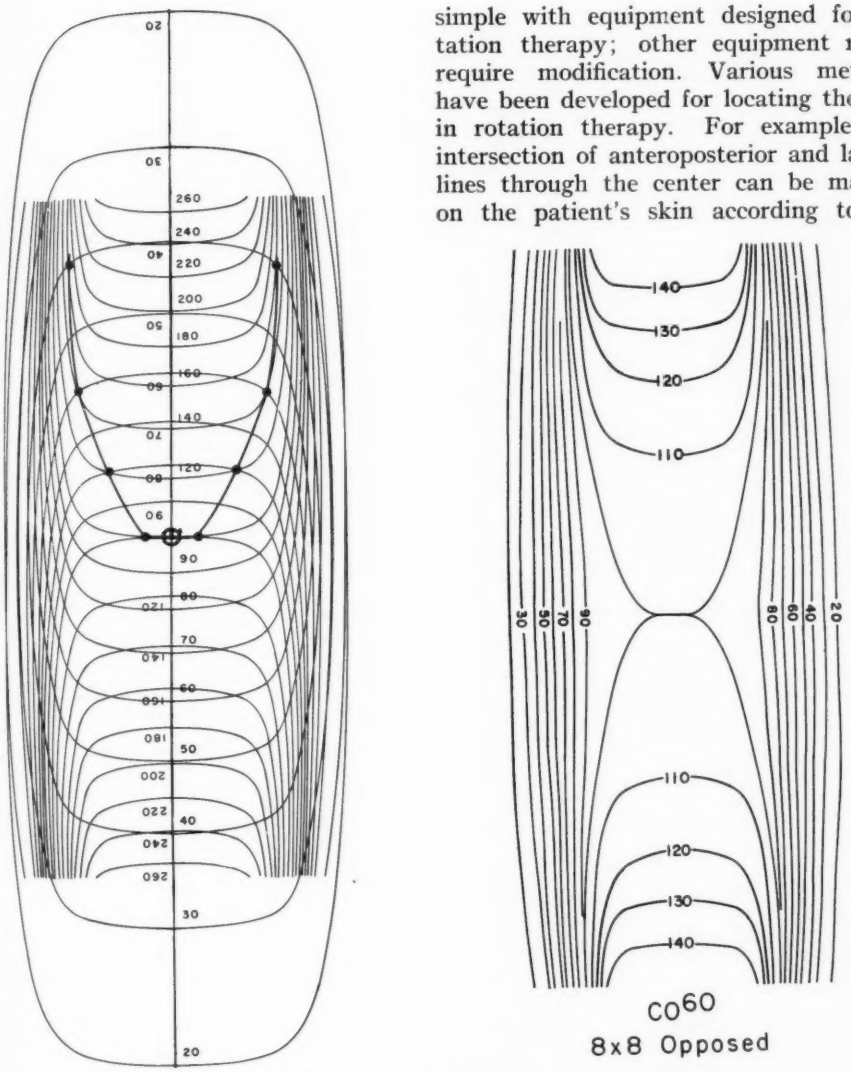
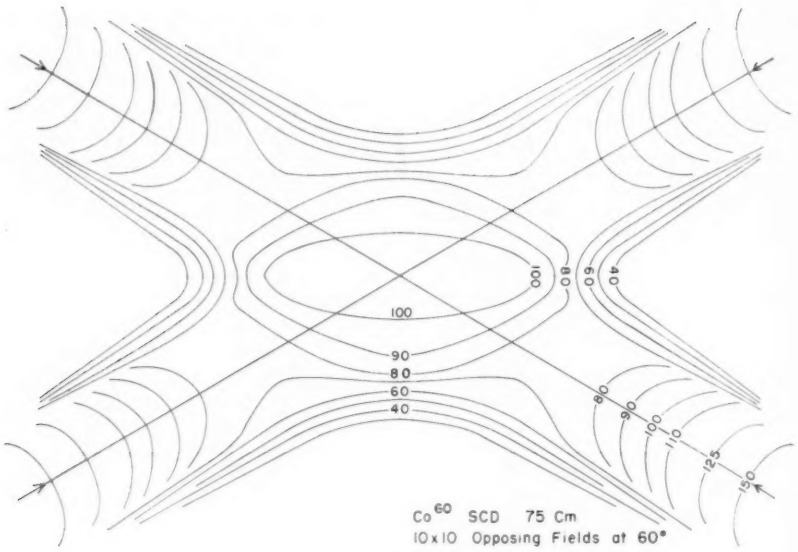


Fig. 2. Method of obtaining composite isodose curves and the resultant curves.

respects as size and number of fields, angles between fields, entrance portals, and location of the fixed point of reference, may be examined for dose distribution in less time than is required to test one plan with conventional curves. This results not only in time saving, but often in better treatment plans, since only a limited time can be spent on the treatment plan for any one patient.

The set-up for such a plan would be simple with equipment designed for rotation therapy; other equipment might require modification. Various methods have been developed for locating the axis in rotation therapy. For example, the intersection of anteroposterior and lateral lines through the center can be marked on the patient's skin according to the treatment plan. Some means of identifying these lines relative to the source should be provided. These can be light beams which intersect at the center, or face and back pointers, etc. When the center is located and its position checked by films, the machine (or the patient) can be rotated until the beam is at the angle required by the treatment plan.

The treatment time will, in general, not be the same for each beam position



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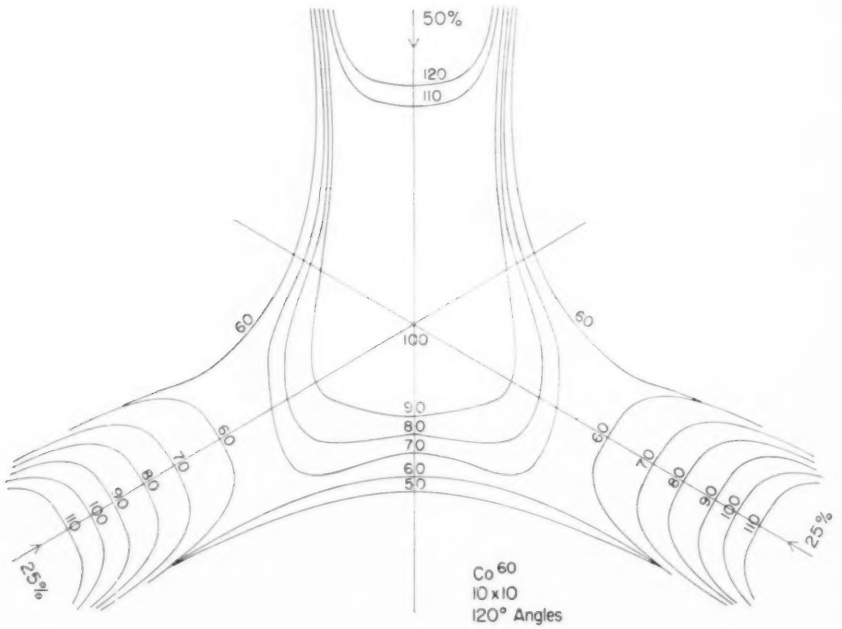

B

Fig. 3. Examples of isodose curves resulting from various combinations of fields.

shown in the treatment plan. Instead of delivering equal doses to each entrance skin portal, as is usual in conventional treatment plans, this type of plan requires delivery of equal doses to the center, with the beam successively in each position shown on the plan. Since the center is always at the same distance from the

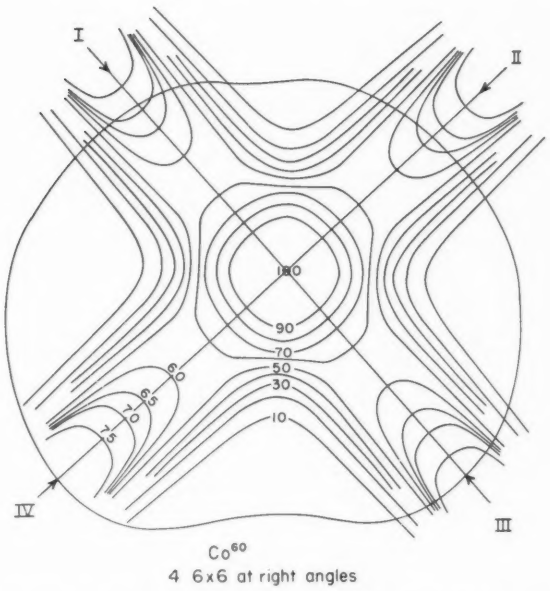

Fig. 4. Contour of patient overlying treatment plan chosen for off-center tumor.

Calculation of treatment time

	Distance from Center to Surface (cm.)	Tumor-Air Ratio	r/min. at Center	Time to Deliver 50 r
Position I	10.6	0.622	33.9	1 min. 28 sec.
Position II	9.5	0.665	36.2	1 min. 23 sec.
Position III	12.9	0.541	29.4	1 min. 42 sec.
Position IV	14.7	0.486	26.4	1 min. 54 sec.

Tumor-air ratios for cobalt 60, taken from Johns *et al.* (2), 6 × 6 cm. field

8 cm depth.....0.726	12 cm depth.....0.573
10 cm. depth.....0.646	14 cm. depth.....0.507
16 cm. depth.....0.449	

source, the treatment time will depend on the thickness of tissue between the source and the center, which may be different for each position. The time will, of course, also depend on field size. If the equipment is calibrated in air dose at the center, the tissue dose at the center may be obtained by multiplying the air dose by the appropriate tumor-air ratio in the tables published by Johns *et al.* (2).

To illustrate the method of calculating treatment times by an example, let us suppose that the treatment plan chosen for cobalt therapy calls for four 6 × 6-cm. fields (field size being measured at the center) intersecting at right angles, with equal contributions to the center from each field (Fig. 4). Let us say that a total of 200 r is to be delivered to the center on each treatment day, with equal contributions from each field, or 50 r from each. The treatment times will not be the same for all four beam positions, since the center is not located symmetrically with respect to the surfaces. In Position I the beam passes through 10.6 cm. of tissue before reaching the center. Referring to the table of tumor-air ratios, (above), we find that when, the beam size is 6 × 6 cm., the tissue dose at a depth of 10.6 cm. will be 0.622 times the air dose. If the calibration for the equipment is 54.5 r/min. in air, the tissue dose rate at the center will be 0.622 × 54.5 = 33.9 r/min. To

deliver 50 r requires 50/33.9 = 1.47 min. or 1 min. 28 sec. Calculations for the other beam positions are shown in Figure 4.

It will simplify the work somewhat in practice if the figures in the tumor-air ratio tables are converted to multiples of a single air dose figure, say the air dose with a 10 × 10-cm. field. The variation in air dose with field size depends on the design of the particular equipment used, so that the table must be made up individually for each machine.

This method of treatment planning does not necessarily require delivery of equal fractions of the center dose through each field. With an eccentrically located center, this might result in too high a dose near the surface in the longest pathway of the beam through tissue. With a constant source-center-distance, a great depth of overlying tissue means that the surface is near the source and the dose rate is consequently high. In this case it might be advisable to deliver a smaller fraction of the center dose through this field, weighting some other field or fields. Resultant isodose curves can be made up for such a situation (Fig. 3, B) by first multiplying the values of each isodose curve by the fraction of the center dose which is to be contributed by the field in question. Note that the shape of the high dose region is distorted and it may be necessary to shift the location of the center from the center of the tumor because of this, or, if the asymmetry is undesirable, a multiplicity of fields could be substituted for the weighted field.

Neither does the method require treatment of every field on each treatment day. The entire center dose for one day may be delivered through one field, provided the total contribution for the treatment series is distributed among the fields according to the treatment plan. The possibility of altering the relative radiosensitivity of different tissues by the change in fractionation if this is done should be considered, since the tumor would be treated each time, even if not uniformly, while the overlying normal tissues would be treated at longer intervals, or at least with nonuniform dosage.

The method is accurate for all points near the center when this lies at some depth in tissue. It gives values which are too high for points near the surface. In general, these represent dosage to normal tissue, so that the error is usually on the safe side. If it is necessary to know these values accurately, the calculated figures can be corrected to the true figures by referring to an actual depth-dose curve or to the appropriate tumor-air ratio.

The reason for the inaccuracy near the surface lies in the shape of the central axis and off-axis depth-dose curves. When these are plotted on semi-log paper, they are straight lines except near the surface (Fig. 5). The curves used in this method of treatment planning are made in an "infinite" phantom and their central axis values lie on a straight line throughout their length, that is, they do not show the bend as the surface is approached. Conventional isodose curves, incidentally, do not show the similar bend which occurs at the exit surface, and this is usually disregarded when using them.

The method described here is most satisfactory for energies near that of cobalt, since the deviation from the straight line is not great and the error can usually be neglected (Fig. 5). For lower energies, near that of conventional x-rays, the initial increase in scatter below the surface results in a correction so large that it cannot always be ignored, particularly since dosage to superficial structures is usually of importance in treating with these energies. The usefulness of the method here is open to question. On the other hand, when the energy is very high, as for the betatron curve shown here, there is again a large deviation from the straight line, this time due to build-up of electron equilibrium. The dose in this region is usually so low, however, that its calculation is unnecessary.

Tumor-air ratios, of course, apply to the actual doses at the center. In general, the center can be placed deep enough below the surface so that it lies on the straight part

of the central axis depth-dose curve. If, however, for any reason it should be necessary to place it near the surface, the values for points at a depth, calculated from the new type isodose curves' straight-line values, but based on an absolute value read from the curved section, would all be too low, except near the surface. This is an undesirable situation, which could lead to under- or overdosage. The best solution is to plot the tumor-air ratios on semi-log paper, extrapolate the straight line section and depends on its distance from the tumor. In this method, beam size is measured at the center, which usually lies in the tumor, and it is not even necessary to calculate its size for the various entrance portals on the skin, since the collimating system refers to beam size at the center. In the example shown in Figure 4, the various field sizes on the skin are: Position I, 5.2 cm.; Position II, 5.2 cm.; Position III, 5.0 cm.; Position IV, 4.8 cm. In practice, this calculation of field size on the skin is usually neglected,

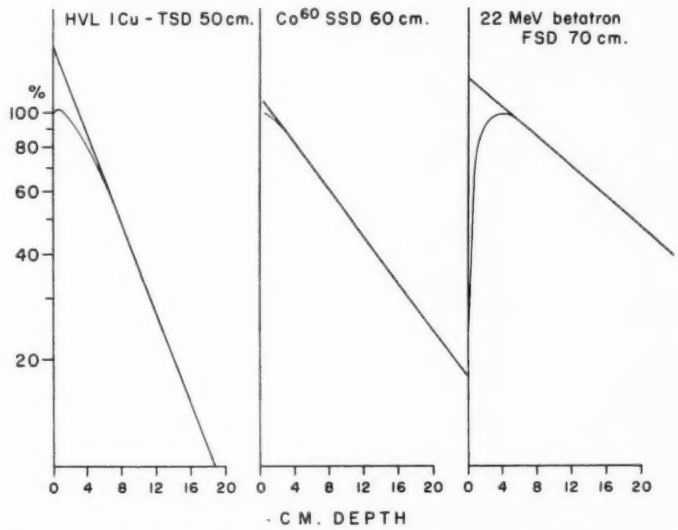

Fig. 5. Deviation of depth dose curves from straight lines on semi-log paper.

to the surface, and use these values throughout. This has the effect of raising the calculated dose near the surface from the true value to the straight-line value of the isodose curves, thus making the calculation of all doses at a depth correct, while those near the surface are too high. In other words, if this alteration is made in the table of tumor-air ratios, dosage will always be calculated on the same basis wherever the center is placed.

There are other advantages of the method of treatment planning described here, beside those mentioned earlier. For example, it is the size of the tumor which actually determines the beam size to be used. Field size on the skin is incidental and in departments using cones it would be impossible to meet the requirements of this treatment plan, so that a 5 × 5-cm. field would be used for all positions. Beam width at the center would then range from 5.8 cm. to 6.2 cm. The effect of this on dose distribution at the tumor is the same as that of penumbra and is something to be avoided.

Furthermore, in the proposed method, with equal contributions from each field to the center and equal angles between fields, dose distribution is always symmetrical about the center, which may be placed at the center of the tumor. Treatment plans using conventional isodose curves are usually based on equal doses, or at most a

simple ratio of doses, to each entrance skin surface. This means that the high-dose region is asymmetrical about the point of intersection of the central axes of the beams when this point is not in the center of the body. To illustrate this point, the treatment plan shown in Figure 4 has been calculated for 5 × 5-cm. fields on the skin and equal doses to each surface (Fig. 6). in the same body cross section is kept below their respective tolerances. In the proposed method all doses are expressed as per cent of the center (tumor) dose, which permits rapid evaluation of a suggested treatment plan. It is for this reason that the resultant isodose pattern due to a combination of fields should be reduced to 100 per cent at the center. The dose per treat-

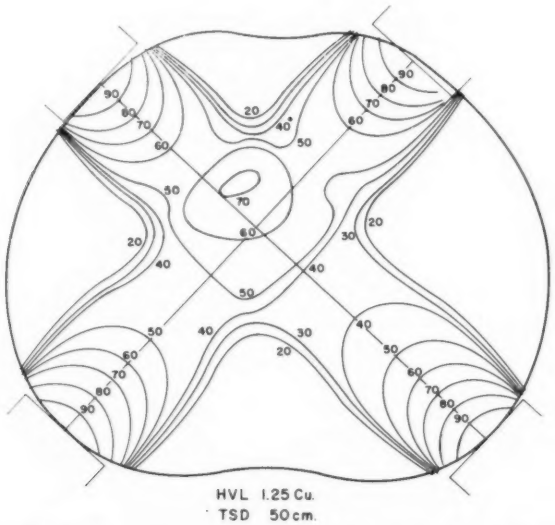

Fig. 6. The same arrangement of fields as that shown in Fig. 4, using the conventional method of treatment planning. All fields measure 5 x 5 cm. at the surface and equal doses are delivered to each surface.

The high-dose region no longer coincides with the tumor. The point of intersection could be shifted, but several trials are often necessary to find the correct location for it, and at best it is necessary to remember many rules for its placement. An alternative method, of course, would be to calculate the entrance surface dose for each field, which would result in equal contributions to the center of the tumor. Obviously, the problem is solved more easily by using the method proposed here.

Finally, the basic dose in radiotherapy is the tumor dose. This is decided upon first. Treatment planning consists of devising an arrangement of fields which will permit delivery of this dose to the tumor while dosage to the various normal tissues ment may be given in terms of tumor dose, and only this need be listed in the record of individual treatments, all other doses being given in the treatment plan or summary.

There are some exceptions to the general plan of placing the center in the center of the tumor beside that of weighted fields already mentioned. For example, in order to spare sensitive normal structures lying in the body cross section under treatment, it may be necessary to use unequal angles between the fields. This results in a high dose region on the side of the center toward the smaller angle (Fig. 7). The amount by which the center must be shifted to compensate for this may be found very quickly by moving the precalculated plan over the

body cross section. Also, in treating an eccentric tumor with a pair of opposed fields (for example, a tonsil), the center must be placed toward the opposite side of the body from the surface lying nearest the tumor. This can be seen by referring to Figure 2 (right). A surface near the center will receive a lower dose than one farther from it because the latter will be nearer the source, where the dose rate is higher.

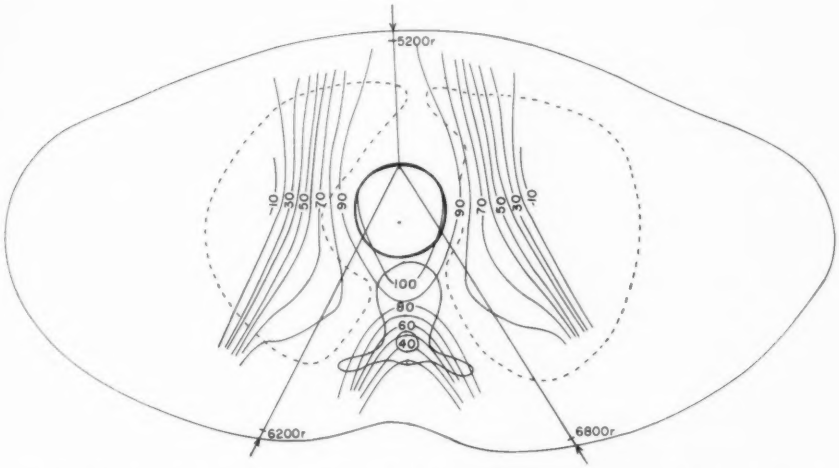

Fig. 7. Treatment plan using unequal angles between fields to avoid the spinal cord and lungs. The center has been shifted from the center of the tumor to its anterior edge because of the asymmetrical dose distribution.

The type of isodose curve used in this method can be obtained by direct measurement, using a phantom deep enough so that the entrance and exit surfaces are not approached closely. It can also be obtained relatively simply from coventional isodose curves by setting the 100 per cent point at the distance from the source at which the center is to be placed, in order that the effect of the inverse-square law may be correct, and relating other values to this, remembering to use the conventional field size on the surface which corresponds to the field size at the center in the proposed system. To illustrate how this could be done: suppose we wish to obtain curves for a 12 × 12-cm. field with the center 60 cm. from the source. Using conventional isodose curves for a 10 × 10-cm. field on the surface and a 50 cm. T.S.D, we convert all values to per cent of the 10-cm. depth dose. Note that the values found will have to be plotted and the bend at the surface eliminated by extrapolating the straight-line section.

SUMMARY

Isodose curves which are independent of patient size or contour may be made up in advance for various combinations of fields. They eliminate the labor of drawing up individual plans for each patient and permit trial of many more treatment plans in a minimum of time.

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SUMMARIO IN INTERLINGUA

Un Methodo Simplificate pro le Planation del Tractamento

Curvas isodosic, independente del dimensiones e del contorno del patiente pote esser construite de antemano pro varie combinationes de campos. Illos elimina le labor de preparar planos individual pro omne patiente e rende possibile le essayo de un multo plus grande numero de planos de tractamento in un minimo de tempore.

Le dose basic in radiotherapia es le dose al tumor. Le planation del tractamento consiste in trovar un arrangiamento de campos que permitte le livration de ille dose al tumor sin que le dose livrate al histos normal in le mesme section transverse del corpore excede le limites respective de lor tolerantia. In le methodo describite, omne magnitudes de dosage es exprimite como pro cento del dose central (i.e. del dose al tumor). Isto permitte un evalutation rapide del proponite plano de tractamento.

Opacification of an Atelectatic Lung Segment During Selective Angiocardiography[1]

HAROLD G. JACOBSON, M.D., BERTA M RUBINSTEIN, M.D., and DORIS J. W. ESCHER, M.D.

THE DEMONSTRATION of the vasculature in an atelectatic lung segment in man *via* selective angiocardiography comprises a unique experience, no example having previously been recorded in the literature.

The blood supply to an atelectatic lung segment in animals has been demonstrated experimentally. In 1912, Bruns (1) described the circulation in atelectatic lungs in rabbits. He showed that the normal rabbit lung contains more blood than the atelectatic lung and receives more blood per unit of time. He also reported that, in spite of collapse of an entire lung, the oxygen saturation of the arterial blood was not lowered and the carbon dioxide content not increased. He stated that there was no blood flow in the capillaries in an atelectatic lung (following artificial pneumothorax). Bruns' measurements of blood flow were made by direct cannulization.

Gilroy, Wilson, and Marchand (2), in 1951, reported that collapse of a pulmonary lobe or an entire lung does not necessarily cause systemic arterial anoxia. In 8 patients with collapse of a lung or the lobe of a lung, Gilroy and his co-workers demonstrated the systemic arterial oxygen saturation to be normal. Studies of the blood oxygen saturation at various sites in the main pulmonary arteries and veins during operation for the removal of a collapsed and functionless lung or lobe suggested that no pulmonary arterial blood was traversing the lung and that there was a retrograde flow of blood from the bronchial to the pulmonary arteries.

Björk (3) studied the blood flow to atelectatic lung segments in dogs with the aid of angiography. He reported in 1953 that in acute atelectasis of one lung the ipsilateral pulmonary artery maintained its caliber and the capillary bed remained open, as indicated by the filling of the pulmonary arteries and veins with contrast medium bilaterally. Björk concluded that acute atelectasis present for one hour does not significantly decrease the blood flow through the atelectatic segment. After the atelectasis had persisted for one and one-half months, practically no opacified blood could be seen passing through the collapsed segment.

Bulgarelli (4) reported in 1955 that, in a case of atelectasis of the left lower lobe, an intravenous angiocardiogram showed hypercirculation in the opposite lung, with dilatation of the opposite pulmonary artery and visualization of numerous small, usually undetected vessels. He described hypovascularity of the atelectatic lung. These findings do not coincide with our observations.

CASE REPORT

R. M., a 6-year-old white boy, was admitted to Montefiore Hospital for the first time on April 20, 1956, from the Cardiac Clinic. The child had been born at full term, weighing 6 pounds and 4 ounces at birth. Delivery was uncomplicated and development normal. The past history included rubella at the age of one year, pertussis at two years, and pneumonia at three years. The child was said to have had a heart murmur since birth but had been relatively well, with no cyanosis, squatting, or congestive failure, but with a questionable history of diminished exercise tolerance. The maternal grandmother had died at the age of forty-five from heart disease, and a maternal cousin, who was cyanotic, had died at the age of nineteen.

On physical examination, there were no pertinent abnormalities except those related to the heart. On auscultation, a grade-3 systolic murmur, with a palpable thrill, was noted along the lower left sternal border, transmitted over the entire precordium. There was a long, loud, harsh, high-pitched systolic murmur maximum in the third and fourth interspaces along both sides of the sternum. P-2 was greater than A-2. Frontal and lateral roentgeno-

[1] From the Divisions of Diagnostic Radiology and Medicine, Montefiore Hospital, New York, N. Y. Accepted for publication in August 1958.

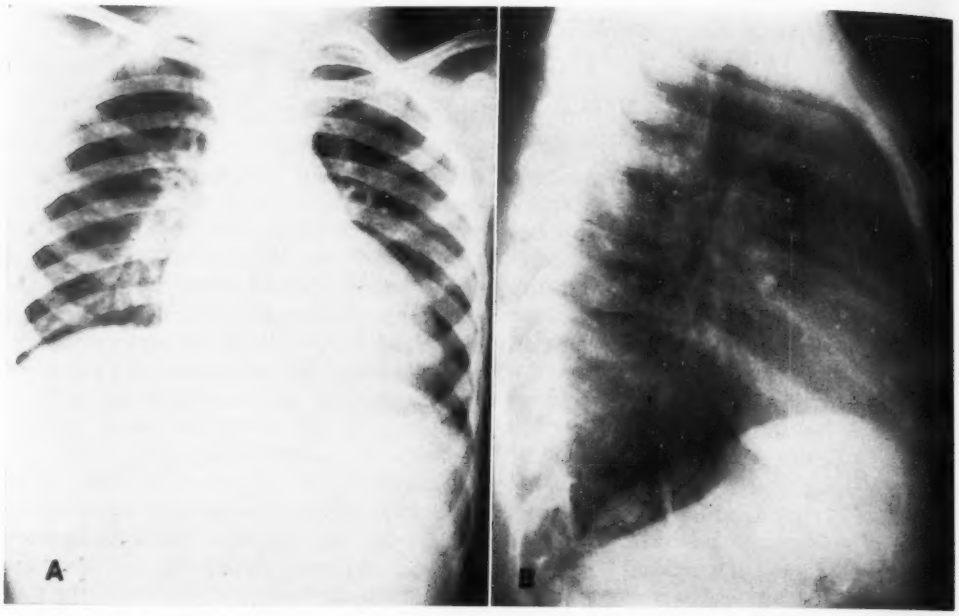

Fig. 1. A. Frontal chest roentgenogram (at time of admission) showing slight pulmonary arterial hypervascularity and somewhat enlarged heart.
B. Lateral film at time of admission. The slight substernal cardiac bulge suggests an element of right ventricular enlargement.

grams of the chest showed slight pulmonary hypervascularity with slight right ventricular enlargement (Fig. 1). A clinical impression of interventricular septal defect with possible mild pulmonic stenosis was entertained.

Fig. 2. A frontal plain view obtained as a preliminary to selective angiocardiography with the catheter tip in the right main pulmonary artery. The right upper lobe atelectasis is noted.

Cardiac catheterization was carried out on April 24, 1956, after preliminary sedation with morphine and Banthine. Endotracheal intubation was performed under ether anesthesia and the child was then maintained with nitrous oxide 70 per cent and oxygen 30 per cent. A No. 5 radiopaque Cournand catheter was passed through the left brachial vein across the mediastinum into the superior vena cava. Saturation studies obtained with a Waters-Connelly oximeter showed: superior vena cava, 79.5 per cent, 81 per cent, and 83 per cent; inferior vena cava, 78 per cent; right auricle, midflow, 79 per cent and 81 per cent; right auricle, outflow, 80 per cent; right ventricle, inflow, 79 per cent; right ventricle, apex, 83 per cent; right ventricle, outflow, 91 per cent; right main pulmonary artery, 84 per cent; left main pulmonary artery, 82 per cent and 85 per cent; femoral saturation samplings at beginning and end, 95.5 per cent and 96 per cent.

Pressure readings were: in the right auricle, 6 mm. Hg; in the right ventricle (inflow toward apex or midflow), 36–44 mm. systolic and 3–7 mm. diastolic, with a mean of 25; in the pulmonary artery, 30–45 mm. systolic over 13–26 mm. diastolic, with a mean of 29. The femoral artery pressure was 100-111 mm. over 55–62, with a mean of 73.

The diagnosis on cardiac catheterization was a relatively small interventricular septal defect with a slight degree of right ventricular hypertension.

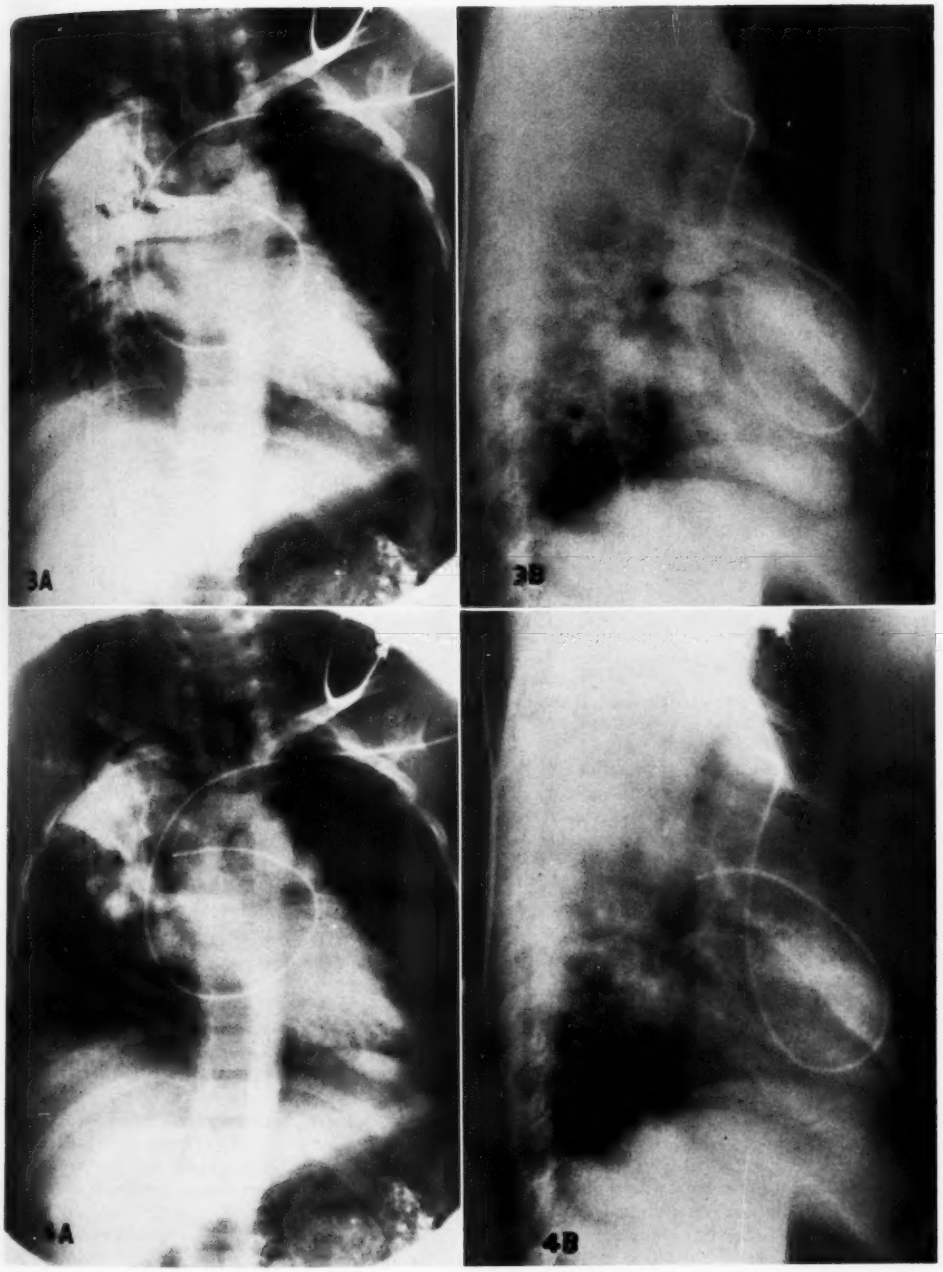

Fig. 3. A. Frontal roentgenogram (1st exposure) after injection of 20 c.c. of Urokon. The atelectatic right upper lobe shows considerable compression of the opacified arterial blood, giving the appearance of a marked increase in density. The lower two-thirds of the right lung shows a normal arterial vasculature. (The aorta is opacified because the sequence of exposures was not initiated until approximately 10 c.c. of Urokon had been injected.)

B. Lateral view (same numerical sequence as A). The atelectatic right upper lobe is partially outlined anteriorly.

Fig. 4. A. Frontal view (10th film in sequence) showing practically complete clearance of the opaque medium in the lower two-thirds of the right lung, while the atelectatic right upper lobe remains markedly opacified.

B. Corresponding lateral view.

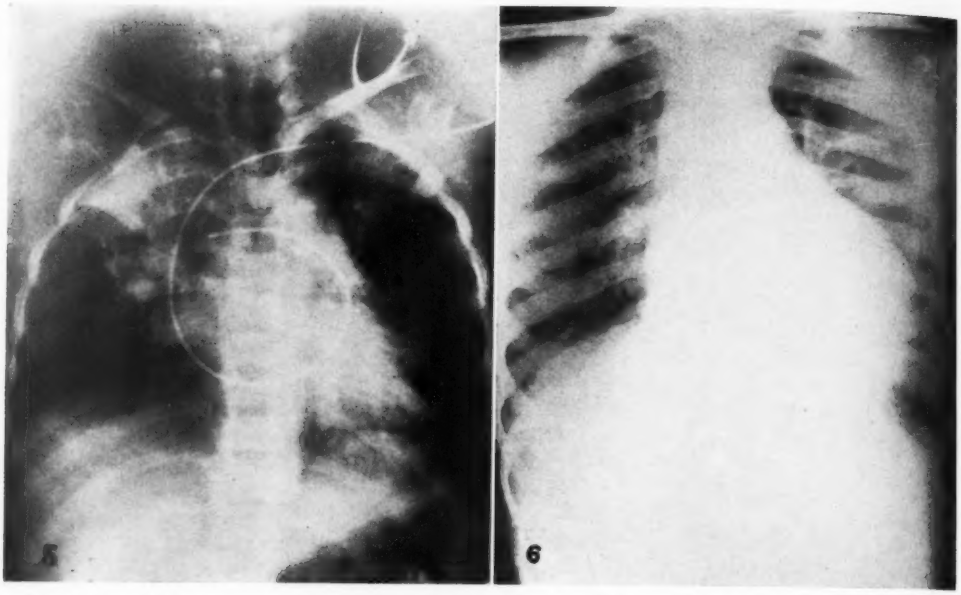

Fig. 5. Frontal roentgenogram (24th film in sequence) showing slight residual opacification of the atelectatic right upper lobe.

Fig. 6. Frontal chest roentgenogram taken at the bedside eight hours after the cardiac catheterization and selective angiocardiogram, showing complete resolution of the right upper lobe atelectasis.

It was decided to attempt visualization of the septal defect through its left-to-right flow by injecting an opacifying medium into the pulmonary artery[2] and demonstrating recirculation *via* the defect. The Cournand catheter was withdrawn and replaced by a No. 5 N. I. H. catheter, which was positioned in the right pulmonary artery.

A chest roentgenogram was exposed in the frontal plane prior to selective angiocardiography, with the catheter seen in the right main pulmonary artery. A collapsed right upper lobe was immediately noted (Fig. 2). This development was felt to be associated with the anesthesia. Despite corrective measures, consisting of forced coughing, suction, etc., the atelectasis persisted. A consultation was held, involving two senior radiologists, the chief of the cardiac catheterization unit, and the senior anesthesiologist. Since the catheter had already been passed, and because the group felt that the lobar atelectasis probably did not diminish vital capacity materially, it was decided to complete the examination in an attempt at visualization and verification of a shunt.

After preliminary testing, 20 c.c. of 76 per cent Urokon was injected through the catheter. The injection was carried out with the aid of a Gidlund automatic pressure syringe, using 7 kg. of pressure per sq. cm. Films were exposed simultaneously in the frontal and lateral planes with the biplane Schönander unit at the rate of six per second for the first two and one-half seconds and three per second for the remainder of the examination. A total of twenty-six roentgenograms in each plane was obtained. The arterial vasculature supplying the atelectatic right upper lobe was seen in the first sequence taken after the injection of the Urokon (Fig. 3). The vasculature in the collapsed lobe was seen to be accentuated, with the vessels considerably compressed. The apparent arterial hypervascularity was probably occasioned by the compression of the vessels in the collapsed lobe. The individual vessels in the collapsed segment appeared slightly dilated. The atelectatic segment retained opacified blood considerably longer than did the rest of the right lung. Thus, the normal lung segments on the right were practically clear of opaque medium by the tenth film in the sequence (Fig. 4), while the atelectatic area was still unusually opaque. The atelectatic segment remained dense in comparison with the preliminary roentgenogram as late as the twenty-fourth film, due to the retention of the opacified blood (Fig. 5). The examination was completed with the child in good condition. Recirculation was not identified; thus the diagnosis of an interventricular septal defect was not substantiated by selective angiocardiography.

Vigorous suction and supportive treatment were continued. A temperature of 103° was recorded

[2] Left-to-right shunts on the ventricular level are best seen *via* reopacification when the catheter tip is placed beyond the area of the shunt in the pulmonary artery or right or left main branch (5).

several hours after the procedure. Bronchoscopy was therefore contemplated, but a portable chest roentgenogram, exposed approximately eight hours after the completion of the cardiac catheterization and selective angiocardiography, showed complete clearing of the right upper lobe atelectasis (Fig. 6). A repeat chest roentgenogram exposed twenty-four hours later in the x-ray department confirmed the observations with the portable unit. The child was afebrile the morning after the procedure and was discharged the following day in good condition.

In spite of the failure to visualize a shunt *via* selective angiocardiography, the clinical findings and catheterization studies in this case strongly suggest an interventricular septal defect. The child will be explored at a later date to verify the presence of such a defect and, if one is found, to effect its closure.

SUMMARY AND CONCLUSIONS

A case is reported in which vascular opacification of an atelectatic lung segment was obtained by selective angiocardiography after the production of lobar collapse at the beginning of cardiac catheterization. The vasculature in the collapsed segment showed significant compression, with accentuation in the early phases, and considerable retention of opaque medium late in the sequence, when compared with the nonatelectatic lobes of the same lung.

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SUMMARIO IN INTERLINGUA

Opacification de un Atelectatic Segmento Pulmonar Durante Angiocardiographia Selective

Es reportate un caso in que opacification vascular de un atelectatic segmento pulmonar esseva obtenite per angiocardiographia selective post le effectuation de collapso lobar al comenciamento de cathèterismo cardiac. Le vasculatura in le segmento collabite revelava grados significative de compression, con accentuation in le phases initial e un retention considerabile de substantia de opacification plus tarde in le sequentia, quando comparate con le lobos non-atelectatic del mesme pulmon.

Plaster Casts for Radiation Therapy of Oral Carcinoma

MARION F. MAGALOTTI, M.D.

BRIEFLY STATED, the aim of radiation therapy is to deliver to a given lesion an effective dose of radiation with accuracy, and by accuracy is meant much more than a well calibrated source and good records. The question always to be kept in mind is this: "Was the tumor dose listed in the record delivered to the lesion?" How often one sees a record of an apparently adequate course of therapy that does not quite correspond to the location and extent of the disease process. The location of a port and the direction of the beam through that port should not be determined haphazardly. Use of an unusually large port, to make more certain that one hits the lesion can hardly be advised. Nor does a round, square, or rectangular cone always quite fit the particular case. It is possible, of course, after careful study, to determine the size and configuration of the lesion, and mark the appropriate ports on the skin with a dye, but with a shave or a good washing, the carefully arranged markings promptly disappear. Furthermore, few out-patients care to walk around for four to six weeks with designs marked in color on the face and neck.

Several years ago, with the above problems in mind, the routine use of plaster casts was adopted for malignant tumors of the mouth, pharynx, and larynx. When such accessories are presented for radiation therapy, the immediate response of the therapist is likely to be: "We haven't the time or facilities for that sort of thing!" The procedure to be outlined here is simple but effective.

TECHNIC

The port is outlined on the patient's skin with a dye such as carbol fuchsin. It need not conform in size or configuration to the cones which are available, as will be shown later. If a check on the location seems advisable, a radiograph may be taken with the patient in position for treatment on the therapy machine. Figure 1 shows such a radiograph obtained to check the beam of radiation directed to a lesion of the posterior third of the tongue and cervical nodes (factors: 35 kv, 18 ma, 50 cm. F.S.D., time five seconds, Thoraeus III filter). For the casts, resin plaster of Paris is used in the form of rolls, 4 inches wide, one roll usually being sufficient for a case. This form of plaster is lighter in weight, dries faster, and is easier to handle than ordinary plaster of Paris. Figure 2 shows a patient with the ports marked on the skin

Fig. 1. Radiograph taken on a 200-kv therapy unit to check the accuracy of the radiation beam in treating a carcinoma of the posterior third of the tongue (arrow) and the first echelon of lymph nodes.

[1] From Cook County Hospital, Chicago, Ill. (M. F. M., Director of Therapeutic Radiology). Presented before the Chicago Roentgen Society in the Fall of 1957. Accepted for publication in September 1958.

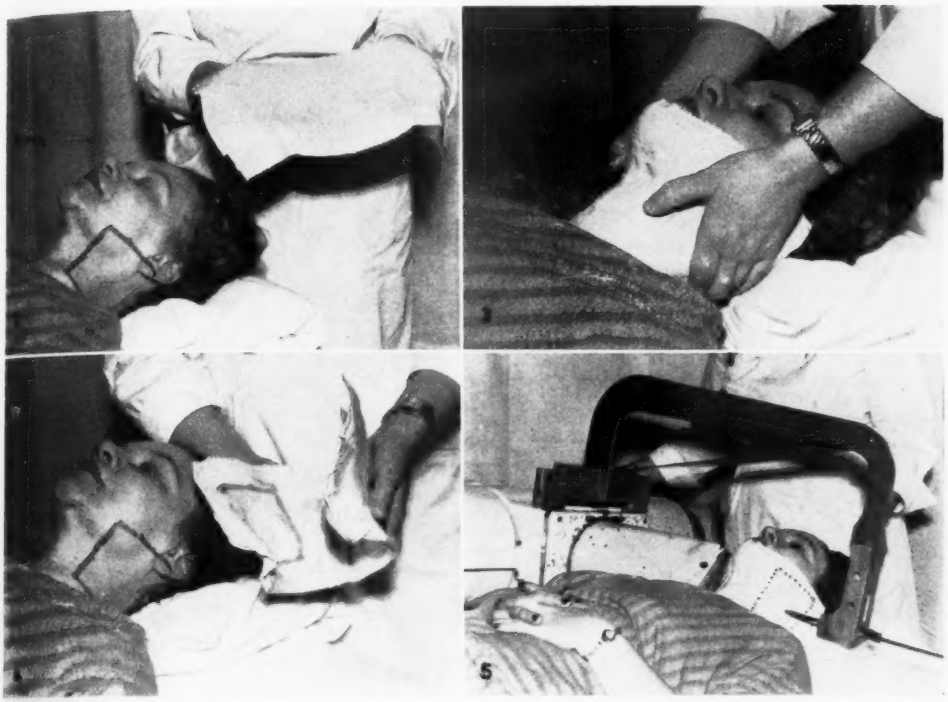

Fig. 2. The therapy port outlined on the skin with dye. The technician holds in her hands the resin plaster of Paris rolled out flat.

Fig. 3. The resin plaster of Paris being moulded to the contour of the patient.

Fig. 4. The plaster cast removed from the patient. The markings that had been made on the skin are now visible on the inner surface of the cast.

Fig. 5. The port outline—size and configuration—has been transferred to the outer surface of the cast. The patient is now ready for treatment with the aid of a back-pointer.

and the technician holding the resin plaster of Paris that has been rolled flat.

The plaster is immediately molded to the contour of the patient as shown in Figure 3. This must be done rapidly, since the plaster dries quickly. In five minutes, the cast can be removed. Figure 4 shows a cast immediately after removal from the patient.

Although thin, the cast has some elasticity and will not crumble with handling. On its inner surface the markings previously made on the skin are now visible. This automatic transfer of port size and configuration from the patient's skin to the inner surface of the cast is especially advantageous. With a small caliper, or by insertion of a few straight pins through the cast along the inner design, the markings can easily be transferred to the outer surface.

With the cast reapplied, therapy may be begun, as shown in Figure 5. The patient is shown here in the horizontal position with a back-pointer in place. A sitting position may also be used, in which event the cast is held snugly in place by a few circles of muslin gauze, while a head rest furnishes support for the patient. The patient's name is written on the cast and it is used for every treatment of the course of therapy.

Figure 6 shows casts of 3 patients. With the addition of a piece of lead rubber (1.5 mm. Pb equivalent) of appropriate shape and size, the specially designed ports can be made adaptable to conventional cones. By cutting off unnecessary corners, the volume of tissue irradiated is reduced and discomfort is thus decreased. On the cast to the left (A), a conventional 10 × 15-cm.

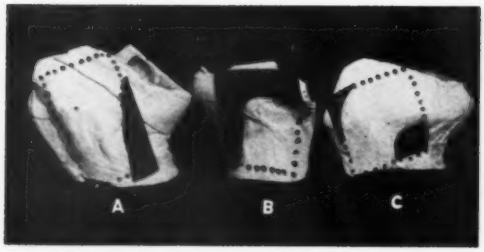

Fig. 6. Three plaster casts with the size and configuration of the port adjusted by the use of lead rubber, thus permitting the use of conventional cones. See text.

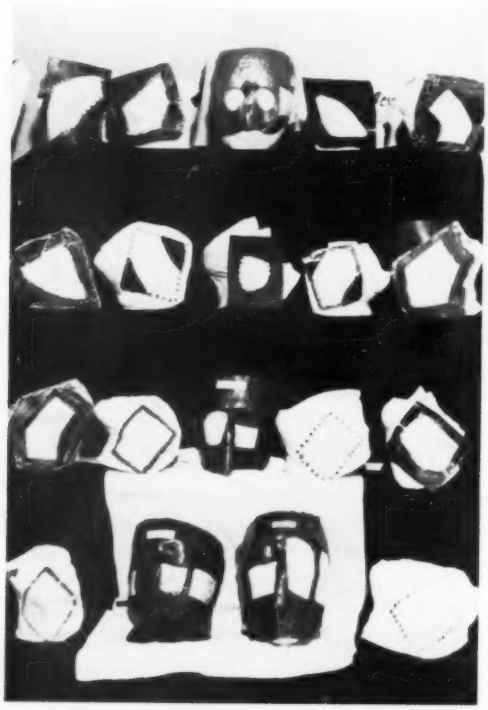

Fig. 7. A group of plaster casts and lead masks that were used for a variety of lesions.

cone was used, with the unnecessary portion cut off to protect the larynx. The lead rubber is held in place by scotch tape or preferably by a staple. The cast on the right (C) was for an oral lesion with cervical metastasis (note the special configuration of the port). A conventional 10 × 10-cm. cone was used but the lead rubber removed the unwanted portion of the beam. Cutting off the anterior-inferior corner of

Fig. 8. This patient has received radiation therapy through a cast. The sharply demarcated skin reaction indicates that the identical area was accurately treated each time.

the beam is especially useful in this type of case to avoid overlapping of opposing fields that would overtreat the skin in the submental region.

Figure 7 shows some casts and lead masks in current use. The initial negatives for the lead masks were also made from the resin plaster of Paris.

COMMENT

With the use of a simple cast such as has been described, one can retreat accurately the initial port without repeated examinations. This is of the utmost importance, especially if the treatments are given by technicians. Figure 8 shows a case that was treated with a plaster cast as a guide. The port is outlined by the radiodermatitis. The sharply demarcated edges leave little doubt that therapy was repeatedly given accurately to the intended area.

There is some attenuation of the radia-

tion beam because of absorption in the cast but this is slight, repeated measurements having shown consistently about 95 per cent transmission (factors: 200 kv, F.S.D. 50 cm., h.v.l. 2 mm. Cu). Correcting for the small amount of absorption within the cast is no problem.

The cast produces no apparent discomfort during the treatment. Actually, the patients look upon it as a little added personal attention and care in the treatment of their serious problem.

Plaster casts for cancers of the mouth, pharynx, and larynx are now routinely used in our department, except in far advanced cases for which only a short palliative course is planned. Over 100 cases have been thus treated. The value of this aid in the administration of radiation therapy far overshadows the expenditure of the fifteen or twenty minutes required for its preparation.

SUMMARY

A simple technic for the irradiation of cancers of the mouth, pharynx, and larynx with the aid of an individually designed plaster of Paris cast has been described. By this means a treatment port adapted to any particular lesion may be outlined without the limitations imposed by the routine use of conventional therapy cones. Accurate relocalization of the port is possible without repeated marking of the skin.

NOTE: Acknowledgment is made to Lois Kaufman, R.N., R.T., whose capable assistance made possible the successful development of the plaster-cast technic.

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SUMMARIO IN INTERLINGUA

Modulos de Gypso pro le Radio-Therapia de Carcinoma Oral

Es describite un simple technica in que modulos de gypso es usate como adjuta in le radio-therapia de canceres de bucca, pharynge, e larynge. Per medio de illo un porta de tractamento adaptate al lesion del caso individual pote esser delineate sin le limitationes imponite per le routine del conos conventional. Illo etiam permitte le accurate re-localisation del porta de tractamento sin repetite marcage del pelle.

Osteotomy of the Spine; Formation of a Wedge Vertebra in the Hyperextension Gap

MICHAEL BURMAN, M.D.

TWO MAJOR SKELETAL events take place in the ankylosing spondylitis which is called Marie-Strümpell disease: fixation of the costovertebral joints, which makes breathing shallow, and abdominal and flexion deformity of the neck and spine. The first of these changes may possibly be relieved by the resection in series of the involved joints or of the adjacent rib. This has never been done. The probability of failure is high in this self-fusing disease.

The postural deformity in flexion may be so great that the afflicted one can see nothing but the ground when he walks. He may try to straighten the spine by bending the hips and knees. He sits in bed, for he cannot lie flat on his back. His health is impaired by the spatial restriction of the thoracic and abdominal viscera, the visible sign of which is a deep transverse crease in the middle or upper part of the abdominal wall. The belly is swollen below the crease. The hip joint may also be involved, adding its flexion deformity to that of the spine.

There is no specific treatment for Marie-Strümpell disease. Its cause is not known. It is linked to rheumatoid arthritis but the pattern of the two illnesses is different. Any treatment is symptomatic and hence palliative. Roentgen therapy to the diseased spine relieves pain but, according to Frohman and his associates, carries with it the risk of later leukemia.

Two surgical procedures have been used —(*a*) the indirect or bypassing extension osteotomy of the upper end of each femur (Milch), which seems to straighten the back, and (*b*) direct osteotomy of the spine, especially in the "parenthesis" form described by Sotelo-Ortiz. The concept of the latter operation follows on the observation of correction of spinal deformity after fracture of the ankylosed spine, as in McMaster's case. Surgically the procedure is

Fig. 1. Preoperative photograph taken in February 1957. This woman, thirty-six years old, underwent osteotomy of the spine on March 7, 1957. The technic of Adams was followed, with immediate manual correction of deformity by three-point pressure.

analogous to the osteotomy used in the correction of other joints held firmly flexed. It is certain that the spine should not be made straight by (closed) manipulation, for this invites paraplegia, as was observed by the author many years ago. Lichtblau and Wilson reported the death of a patient immediately after manipulation of the spine under general anesthesia. The aorta was found to be adherent to the anterior longitudinal ligament and the posterior wall was torn transversely at the exact site of the hyperextension gap, 3 cm. wide, at the level between L-1 and L-2. The patient had received several courses of roentgen therapy for a total dosage of 2,000 r, and it was believed that the radiation might have scarred the aortic area.

The definitive open osteotomy of the

[1] From the Hospital for Joint Diseases, New York, N. Y. Accepted for publication in September 1958.

Fig. 2. Photograph early in March 1958, some weeks after resection of the left femoral head and neck and Schanz angulational osteotomy of the femur (combined technic of Milch). The spine is straight. Continued pain in the hip at rest, made worse by walking even with a cane, and difficulty in sitting made tfiis operation necessary on Feb. 13, 1958.

Fig. 3. Lateral roentgenogram of the lumbar spine taken on Feb. 12, 1958. A well trabeculated wedge of bone may be seen filling the hyperextension gap between L-2 and L-3.

spine is credited to Smith-Petersen and his colleagues. McMaster reviewed the modest literature on this operation. It is usually done at a midlumbar level; very rarely in the neck (Urist) or dorsal spine (Herbert), depending on the site of greatest deformity. The "question-mark" deformity would properly call for osteotomy of the dorsal spine. A large wedge of bone with posterior base is removed, including the adjacent spinous processes, the laminae, and the fused apophyseal joints. When the *coarse* bone is resected, care is taken to spare the dura and the nerve root in the intervertebral foramen on either side.

The operation may be done at one or more levels, seldom more than two. When it is carried out at one level, as in the technic of Adams, the hinge point is the posterior part of the intervertebral disk. The upper vertebra tilts on the lower one. Correction, immediate or delayed, is three-point and is limited not by the size of the wedge of bone which can be removed but by belly tension and the real possibility of paralytic ileus. The hyperextension gap fills with blood and fragments of fibrous tissue. It does not seem necessary to cut the bony anterior ligament through another incision; as the spine is extended, the breaking of the ligament is indicated by a cracking sound. (When the automobile jack is used to reduce a wedge fracture of a middorsal vertebra, a comparable gap may be opened between two dorsal vertebrae by tearing of the ligament.) Nor is it necessary to fuse the spine, since the disease is by its nature self-fusing, unless there is a posterior gap which leaves dura bare. (Were the reason known for new bone formation in this illness, such knowledge might have possible applica-

tions in operative situations where fusion is needed.)

No hyperextension gap is seen when the correction is small or osteotomy is done at more than one level, as in McMaster's cases. Lichtblau and Wilson found that correction was gained at only one interspace. There was no adding of correction at each of the two or three liberated interspaces.

Later ossification in the hyperextension gap may create a new wedge vertebra, an interesting and unusual event, as in the case shown here (Figs. 1–3). This was seen in La Chapelle's case three months after operation (a two-stage release, first posteriorly and then anteriorly a month later) and again two years after operation. In the first case of Sotelo-Ortiz, irregular new bone was found anteriorly in the small gap in a roentgenogram taken at an unstated time after operation. On the other hand, there need not be a new wedge vertebra, simply because of lack of ossification of the fibrous tissue in the gap, which may be held open by posterior element fusion. This tension of the hinged spine which discourages new bone formation may be offset by the compression of the weight force on a straight spine and the new bone formation native to the illness.

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SUMMARIO IN INTERLINGUA

Osteotomia del Spina Dorsal. Formation de un Vertebra Cuneate in le Interspatio de Hyperextension

Post osteotomia del spina dorsal in morbo de Marie-Strümpell, il occurre que le ossification del interspatio de hyperextension resulta in le formation de un nove vertebra cuneate. Es illustrate un caso de iste phenomeno inusual e interessante. Duo altere casos es citate ab le litteratura.

Thin-Crystal Scintillation Counter[1]

K. E. CORRIGAN, Ph.D., and H. S. HAYDEN, Ph.D.

The preoperative detection and identification of many types of lesions such as mediastinal tumors (1) have depended upon the use of the Geiger-Müller counter. The conventional scintillation counter has been generally inapplicable due to its size and weight. The necessity for collimation with a thick crystal has required increased distance which more than offsets the scintillation counter's greater sensitivity for gamma rays (usually by a factor of 2 or more), and until recently (2, 3) this instrument has had no significant sensitivity to the soft x-rays from a lesion activated with P^{32}. For these reasons experiments were begun about eighteen months ago using thin NaI and CsI crystals of various diameters.

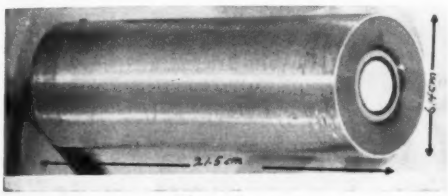

Figure 1

In counting for the purpose of detecting, locating, and outlining a lesion (in contrast to pulse-height analysis, for example) only the first few millimeters of the crystal are necessary. A thin crystal requires a negligible shielding weight and has an inherent spatial sensitivity similar to a good, properly shielded G-M tube with many times the sensitivity of the tube.

Detailed theoretical and practical considerations will be given elsewhere (4), and further work is in progress. It appears that a crystal about 3 mm. in thickness and 25 mm. in diameter is optimum. A beryllium window has not proved helpful. For the past six months a practical thin-crystal counter has been in use and has proved highly advantageous for many types of diagnostic procedures such as the preoperative localization of malignant brain tumors.

The present counter is shown in Figure 1. It has a conventional PM-PA chassis, a 3 × 25-mm. NaI (Tl) crystal, with an 0.10-mm. Al window. Shielding consists of a Pb ring 12.5 mm. thick surrounding the crystal and extending 15 mm. behind it around the magnetic shield. The entire instrument weighs 1,180 gm. (2.6 lb.). Response curves (Fig. 2) of this counter to two phantom "lesions," each under a slab of Lucite 25 mm. thick are reproduced in Figure 2: (*a*) 0.35 μc I^{131}, 5 mm. in diameter; (*b*) 6.0 μc P^{32}, 2.0 cm. in diameter.

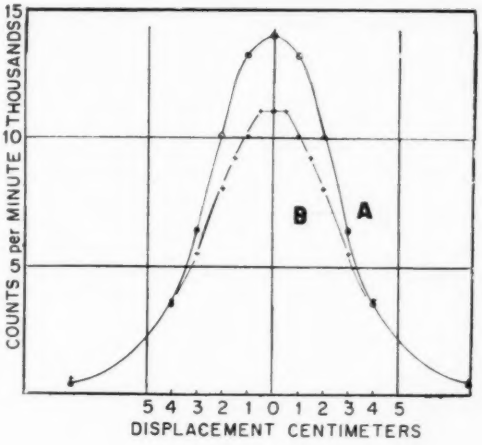

Figure 2

The G-M tube is still the reference instrument, but the thin-crystal counter has equal versatility and as much as fifty times the sensitivity. As in the surgical probe counter (5), the relative sensitivity and background can be varied to suit the problem by varying the operating voltage. Student physicians are currently learning to use the new instrument.

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Determination of Half-Value Layer

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In the determination of half-value layer, the geometry involved is usually described as "good" geometry or "poor" geometry. In general, these terms have reference to measurements made under narrow-beam and broad-beam conditions. Such conditions have not been too well explored.

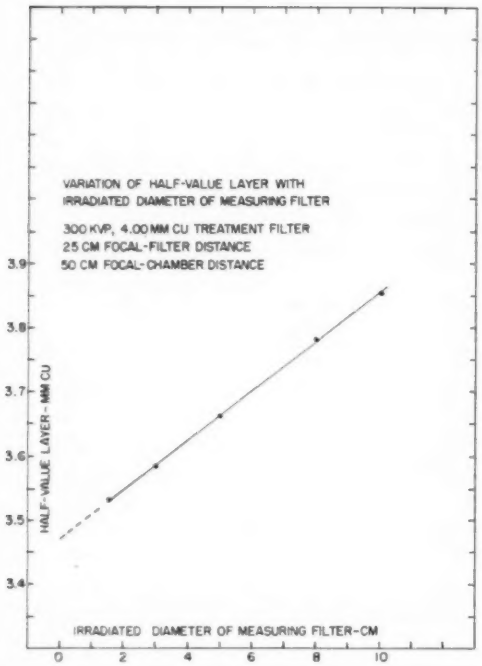

Fig. 1. Variation of half-value layer with irradiated diameter of measuring filter.

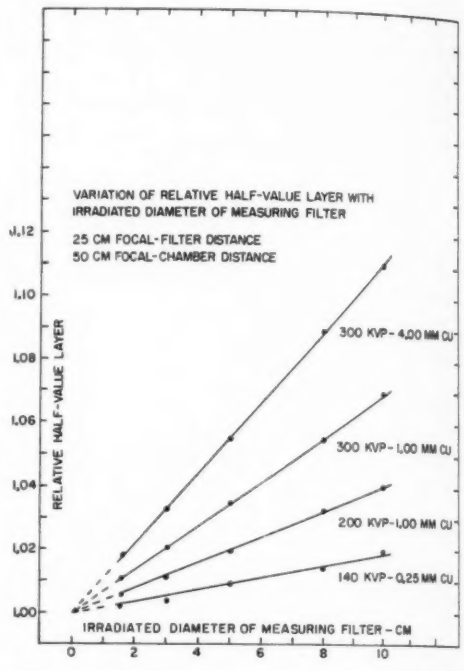

Fig. 2. Variation of relative half-value layer with irradiated diameter of measuring filter.

Narrow-beam determinations can always be made under laboratory conditions, but such conditions may not lend themselves to measurement technics in a working therapy installation, where restrictions may be imposed by equipment limitations on filters and diaphragms.

The object of our investigation is the derivation of information that might be used to correct a half-value layer determination made under generally available conditions to some common denominator that could be described as narrow-beam conditions. We are presenting here the first phase of a study, the full report of which will cover the variables involved and their influence on the resulting determination. It has been found, as had been expected, that the irradiated area of the filter which is added to the treatment filter has a major influence on the determination. An effort to plot half-value layer against filter area does not yield a straight line and extrapolation to zero area therefore becomes difficult. It has been found that half-value layer is a linear function of the diameter of the measuring filter. Data so plotted are presented in Figure 1.

To provide readily usable data, it has been found advisable to plot relative half-value layer against filter diameter. The relative half-value layer is obtained by dividing the half-value layer for a given filter diameter by the half-value layer obtained by extrapolation to zero diameter. The half-value layer for zero diameter is taken from a plot similar to Figure 1. A plot of values obtained for a series of voltages and treatment filters is shown in Figure 2. By means of such a plot it becomes possible to take data under usual working conditions and from them arrive at the half-value layer that would have been obtained for any other set of conditions. A similar system for square fields is in cource of development.

In the interests of providing widespread agreement as to what constitutes an acceptable half-value layer determination, it appears desirable that some group, preferably the International Commission on Radiological Units and Measurements, should establish some common denominator to which all half-value layer measurements might be reduced.

In a subsequent report, reference will be made to an exploration of all the variables influencing half-value layer determinations over a voltage range from 100 kvp to 2,000 kvp and the usual range of treatment filters used at these voltages.

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EDITORIAL

Pulmonary Findings in the Collagen Diseases

A number of systemic diseases which have been classed together in spite of considerable diversity of manifestations were first called "diffuse collagen disease" by Klemperer and his co-workers in 1942. They applied this term to disseminated lupus erythematosus, scleroderma, and dermatomyositis. Since then rheumatoid arthritis, acute rheumatic fever, periarteritis nodosa, and thrombotic thrombocytopenic purpura have been added. Hamman-Rich syndrome, Whipple's disease, and hypersensitivity angiitis are not included, though it has been suggested that they should be.

This group of diseases involves soft parts generally and blood vessels specifically in many instances. Some mechanisms have been discovered. In the case of lupus erythematosus there is little question about the presence of abnormal proteins in the blood, disturbance of desoxyribosenucleic acid metabolism of the mesenchyme, and the L. E. cell phenomenon. In all of the group, except possibly scleroderma, there must be consideration of hypersensitivity as a pathogenetic factor.

The relationship of the histopathologic changes in these diseases is emphasized by the occurrence of findings characteristic of more than one of the disorders in a single patient; the clinical overlapping of symptom complexes is considerable. Five per cent of patients with scleroderma, for example, show glomerular lesions similar to those of lupus erythematosus. Geschickter and others (8) report that the application of a simple irritant amine to experimental animals is capable of causing the histopathologic changes of all of the more common collagen diseases. In this experimental work, the animals presumably respond in these several fashions to a single injurious substance, which, however, may have many sites of action. Other forms of trauma, even as simple as pinching the skin, can cause the fibrinoid necrosis typical of the group.

The acute manifestations of disseminated lupus erythematosus which may appear on films of the chest include pleural effusions of any size, either unilateral or bilateral, pulmonary edema, and pneumonitis of several types with some predilection for localization in the subpleural areas (Thorell, 17). Patients in this group are also more prone than the general population to ordinary bacterial pneumonias. These probably follow pulmonary edema. Sante and Wyatt (15) have pointed out that edema, congestion, and hemorrhage occur in the lungs when the collagen disease involves the kidneys—the so-called "antigenic (azotemic) pneumonitis." Purnell, Baggenstoss, and Olsen (12) described basophilic mucinous edema, interstitial pneumonitis, and alveolar hemorrhage in some of their cases. The acute pulmonary edema of lupus erythematosus is not always associated with severe cardiac or renal lesions; in this event the edema may be due to the direct action of the disease in the lungs or to protein disturbances. The pulmonary abnormalities in lupus may change quite rapidly. Fibrosis may follow acute lesions or appear without known preceding involvement; it produces a fine linear and nodular pattern, narrowed vessels, and at times cor pulmonale. This may progress to a reticular or fine cystic appearance.

Periarteritis nodosa may also show "antigenic (azotemic) pneumonitis" on the basis of involvement of the general body economy secondary to renal lesions. In addition, changes can result from a

specific local vascular lesion in the pulmonary or bronchial arteries or both (Doub *et al.*, 6; Braunstein, 1). When there is a localized arterial lesion, pulmonary infarction, frequently resulting in cavitation, may be seen. Changing patches of pulmonary edema and hemorrhage are present and may be followed by a linear and fibrotic pattern as in lupus erythematosus. Enlargement of the lung roots is a common roentgen observation. The localized vascular lesions of periarteritis may also cause widespread arterial destruction throughout the lungs. Death usually ensues in a short time. Many lesions of Wegener's granulomatosis may for all practical purposes be considered a localized periarteritis causing an infarct; others are "granulomas" with necrotic centers.

Although in some cases of scleroderma there is a diffuse and patchy infiltrative process in the lungs, indistinguishable from the changes seen in other members of this group of diseases, there is also a typical "sclerocystic" appearance with a very fine honeycomb pattern which is thought to be characteristic. This is the result of coalescence of alveoli and formation of "broncho-alveolar cysts." There is associated marked interstitial fibrous thickening following subepithelial myxomatous change. In some of our material there has been a severe bronchiectasis in the lower lobes.

The nature of the transient densities appearing in the lungs in acute rheumatic fever is not established. Some are probably the result of congestive failure, incomplete infarction, and hemorrhage. However, a highly fatal type of pneumonia has been found in a number of autopsy studies of patients who have had extensive hyaline membrane formation, Masson bodies, and mononuclear cell infiltrates (9, 11, 15). The roentgen appearance in these cases has varied from diffuse mottling to homogeneous consolidation of large portions of both lungs.

Much has been written recently concerning the pulmonary lesions in patients with rheumatoid arthritis. Ellman and Ball (7) and Christie (5) reported complete autopsy study of cases of rheumatoid arthritis with pleural lesions and with lesions in the parenchyma, vessels, bronchi, and lymph nodes of the lungs. These lesions were in all stages of development and of varying degrees of severity. Small foci of necrotizing pneumonia with fibrinoid changes were followed by the development of collagenous tissue. Small necrotic nodules were formed from fibrinous pneumonia, and in one case there was progression to the formation of a massive rheumatoid nodule, 7 cm. in diameter. Fibrotic nodules and strands as well as fibrosis of vessels and bronchi were found. Gresham and Kellaway (10) published a case of rheumatoid arthritis showing cystic changes in the subpleural areas, with reproduction of sections containing both the cystic changes and active rheumatoid nodules. They were unable to establish the origin of the cysts from the granulomatous destruction of lung. Histochemical observations of the lung lesions were similar to those of a juxta-articular rheumatoid nodule. The patient also had cardiac lesions with aortic incompetence, thickening of cusp margins, and fusion of the commissures. The valve showed fibrinoid necrosis bordered by palisading histiocytes. Similar cystic and granulomatous lesions are present in our material (16). Fine fibrotic lesions like the Hamman-Rich syndrome are reported by Read (13).

Coal miners with rheumatoid disease have been found by Caplan (3) to have lung lesions of a particular type, somewhat resembling massive fibrosis, but more numerous, round, and more uniformly distributed through the lungs. These lesions were observed in the presence of slight or no generalized radiographic changes of pneumoconiosis. They developed rapidly and then could remain unchanged or appear in successive waves. Sometimes they disappeared or became fibrotic after cavitation. Some calcified or became incorporated in progressive massive fibrosis. Caplan and others (4) have described this process in a foundry

worker, and it has been seen in pottery workers, sand blasters, boiler scalers (2), and brass and iron foundry workers. Microscopically the border of the lesion shows a rheumatoid type of inflammation with formation of collagen and variable amounts of necrosis.

Typical foci of rheumatoid nodules localized mainly to the subpleural portions of the lower lungs are described in association with asbestosis by Rickards and Barrett (14). They recognized 26 cases of necrobiotic foci of typical rheumatoid lesions and stated that 15 of them were associated with pneumoconiosis. These cases show the altered response of a patient with a particular collagen disease to a given type of injury.

Pulmonary lesions are frequent in lupus erythematosus, periarteritis nodosa, and scleroderma, but infrequent in rheumatic fever, rheumatoid arthritis, and dermatomyositis. WILLIAM R. EYLER, M.D.

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IN MEMORIAM

George Winslow Holmes, M.D.

1876-1959

"It is an honorable object to see the reasons of other men wear our Liveries; and their borrowed understandings do homage to the bounty of ours. . . ."

The "reasons" of many wear the Liveries of Dr. George Winslow Holmes, and the "understandings" of few are more honored by the number who stand in their intellectual debt.

Malignant lymphoma of some one and a half years duration, compiicated by gastric hemorrhage, brought the long and distinguished career of Dr. Holmes to a close in the eighty-third year of his age on March 18, 1959, in Belfast, in the county of his origin, Waldo, Maine.

He was born to George O. and Laura Bartlett Holmes on Dec. 28, 1876. He attended the Belfast schools and Tufts Medical School, from which he was graduated in 1906. Internships at Long Island Hospital and Boston City Hospitals were followed in 1911 by the beginning of his career in Radiology under Walter Dodd at the Massachusetts General Hospital. In 1917 he became Head of the Department, from which position he retired in 1941. In 1913 he received his first appointment to the Harvard Medical School as Assistant in Roentgenology. In 1918 he became a member of the Faculty, first as Instructor; then in 1931, Clinical Professor; and finally, in 1941, Clinical Professor of Roentgenology Emeritus.

Retirement from the Massachusetts General Hospital was brief, for late in 1942 Dr. Holmes was recalled as Acting Chief of the Department of Radiology. From this position he finally retired in 1945 and returned to his native Maine. "Retirement," however, was a technicality. He served as radiologist to the Waldo County Hospital until his death and for a time was also Chief of Staff.

Dr. Holmes served Radiology long and well. His honors were many: he was a founding member of the American Board of Radiology, Past President of the American Roentgen Ray Society, Carman Lecturer of the Radiological Society of North America, Caldwell Lecturer of the American Roentgen Ray Society, and the first George W. Holmes Lecturer of the New England Roentgen Ray Society.

He is survived by his widow, Elsie Young Holmes; a sister, Mrs. Eben F. Littlefield; two brothers, Clyde B. and Gay E., and a number of nieces and nephews.

George Holmes was a physician first; he insisted that he be known as physician to the Department of Roentgenology. As an investigator his many papers attest to his versatility: as an educator his two textbooks for students—"Roentgen Interpretation" and "Roentgen Therapy"—have been outstanding. In the postgraduate medical field he has been conceded as the father of resident training, and one of his greatest joys in life was in the accomplishments of his boys. He was instrumental in the formation of the first tumor clinic in a general hospital in this country.

That George Holmes was a friendly person was obvious to all who were fortunate enough to know him. His indigenous intelligence and wit served his house officers, residents, assistants, associates, and colleagues in a sane way and greatly influenced the development of present day radiology.

George W. Holmes could never be accused of conceit but in the company of the honored, he could say

"The consciousness of having quitted us like men in the employment of our faculties while they were ours to use is no mean consolation."

LAURENCE L. ROBBINS, M.D.
MILFORD D. SCHULZ, M.D.

George Winslow Holmes, M.D.
1876–1959

ANNOUNCEMENTS AND BOOK REVIEWS

THE AMERICAN RADIUM SOCIETY

Newly elected officers of the American Radium Society are: President, Theodore R. Miller, M.D., New York, N. Y.; President-Elect, Jesshill Love, M.D., Indianapolis, Ind.; First Vice-President, Gray H. Twombly, M.D., New York, N. Y.; Second Vice-President, Leonidas Marinelli, M.A., Lemont, Ill.; Secretary, Robert L. Brown, M.D., Winship Clinic, Emory University, Atlanta 22, Ga.; Treasurer, Gilbert H. Fletcher, M.D., M. D. Anderson Hospital, Houston, Texas.

The Forty-second Annual Meeting of the Society will be held in the Caribe Hilton, San Juan, Puerto Rico, March 17–19, 1960.

CHICAGO ROENTGEN SOCIETY

The Chicago Roentgen Society at a recent meeting elected the following officers: President, Edward George Warnick, M.D.; Vice-President, Robert M. Potter, M.D.; Secretary-Treasurer, George B. Cahill, M.D., 802 Burns Ave., Flossmoor, Ill.

Meetings are held at the Sheraton Hotel the second Thursday, October, November, January, February, March, and April, at 8 P.M.

FLORIDA RADIOLOGICAL SOCIETY

Officers of the Florida Radiological Society for 1959–60 are: President, Russell D. D. Hoover, M.D., West Palm Beach; President-Elect, John S. Stewart, M.D., Fort Myers; Vice-President, Alfred G. Levin, M.D., Miami; Treasurer, Ivan Isaacs, M.D., Jacksonville; Secretary, John P. Ferrell, M.D., 166 Fourth Ave., St. Petersburg; Councilors to the American College of Radiology, J. Maxey Dell, Jr., M.D., Gainesville, and Oliver P. Winslow, Jr., M.D., Miami, (Alternate).

INDIANA ROENTGEN SOCIETY

The Indiana Roentgen Society recently elected the following officers: President, John R. Lionberger, Jr., M.D., South Bend; President-Elect, Chester A. Stayton, Jr., M.D., Indianapolis; Secretary-Treasurer, David E. Wheeler, M.D., 1500 North Ritter, Indianapolis.

Meetings are held twice a year: the first Sunday in May and during the fall meeting of the Indiana State Medical Association.

NEW ENGLAND ROENTGEN RAY SOCIETY

At the Fortieth Annual Meeting of the New England Roentgen Ray Society, the following were elected to office: Stanley M. Wyman, M.D., Belmont, Mass., President; Arnold H. Janzen, M.D., Hartford, Conn., President-Elect; Donald P. Ham, M.D., Greenfield, Mass., Vice-President; John E. Gary, M.D., 1180 Beacon St., Brookline 46, Mass., Secretary; Lloyd E. Hawes, M.D., Jamaica Plain, Mass., Treasurer; Mirle A. Kellett, M.D., Boston, Mass., Executive Committee Member at Large.

The Holmes Lecture was delivered by Leo G. Rigler, M.D., Los Angeles, Calif., his subject being "The Place of Radiology in Medical Education."

RADIOLOGICAL SOCIETY OF NEW JERSEY

The Radiological Society of New Jersey at its recent annual meeting elected as officers for the ensuing year: President, William L. Palazzo, M.D., Teaneck; Vice-President, Andrew P. Dedick, Jr., M.D., Red Bank; Treasurer, W. Lawrence Bonnet, M.D., Trenton; Secretary, Austin J. Tidabeck, M.D., 912 Prospect Ave., Plainfield.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY

Newly elected officers of the Northeastern New York Radiological Society are: President, Sidney I. Etkin, M.D., Albany; Vice-President, Everett Jacobs, M.D., Hudson; Secretary-Treasurer, Irving Van Woert, Jr., M.D., Albany Hospital, Albany.

OKLAHOMA STATE RADIOLOGICAL SOCIETY

At the Spring meeting of the Oklahoma State Radiological Society the following were elected to office: E. H. Kalmon, M.D., of Oklahoma City, President; J. R. Danstrom, M.D., of Oklahoma City, Vice-President; J. Murphree, M.D., 617 East Brookfield, Ponca City, Secretary; V. M. Lockard, M.D., of Bartlesville, Treasurer.

The guest speaker at the meeting was Don C. Weir, M.D., of St. Louis, Mo., whose subject was "Injuries of the Cervical Spine." A film-reading session followed his presentation.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY

At the recent annual meeting of the Pacific Northwest Radiological Society, held in Seattle, Wash., the following officers were elected: President, John S. Madill, M.D., Vancouver, B. C.; President-Elect, William Y. Burton, M.D., Portland, Ore.; First Vice-President, Frank J. Rigos, M.D., Tacoma, Wash.; Second Vice-President, A. Thomas Wiens, M.D., Vancouver, B. C.; Executive Committee members, Robert W. Hanf, M.D., Kennewick, Wash., and C. Todd Jessell, M.D., Portland, Ore.; Secretary-Treasurer, J. Arch Colbrunn, Jr., M.D., 164 W. Tanager St., Roseburg, Ore.

The next Annual Meeting of the Society will be held in Vancouver, B. C., in May 1960.

PENNSYLVANIA RADIOLOGICAL SOCIETY

The Pennsylvania Radiological Society recently elected the following officers for 1959–60: President, D. Alan Sampson, M.D., Ardmore; President-Elect, Carl B. Lechner, M.D., Erie; First Vice-President, Thomas J. Conahan, M.D., Hazleton; Second Vice-President, Thomas A. Campbell, M.D., York; Secretary-Treasurer, Walter P. Bitner, M.D., 234 State St., Harrisburg; Editor, John H. Harris, Jr., M.D., Philadelphia; Associate Editor, Marlyn W. Miller, M.D., Altoona; Councilor to the American College of Radiology, John H. Harris, M.D., Harrisburg; Alternate Councilor to the American College of Radiology, Newton Hornick, M.D., Pittsburgh.

The next Annual Meeting of the Society will be held at Pocono Manor, May 14–15, 1960.

PHILADELPHIA ROENTGEN RAY SOCIETY

The Philadelphia Roentgen Ray Society has chosen as its officers for 1959–60: President, Herbert M. Stauffer, M.D.; Vice-President, J. Francis Mahoney, M.D.; Secretary, Robert B. Funch, M.D., Department of Radiology, Germantown Hospital, Philadelphia 44; Treasurer, Randal A. Boyer, M.D.; Councilor-at-Large, John T. Brackin, Jr., M.D.

AMERICAN UROLOGICAL ASSOCIATION

The American Urological Association is offering its annual award of $1,000 (first prize of $500, second prize $300, and third prize $200) for essays on the result of some clinical or laboratory research in urology. Competition is limited to urologists who have been graduated not more than ten years, and to hospital interns and residents doing research work in urology.

The first prize essay will appear on the program of the forthcoming meeting of the American Urological Association, to be held at the Palmer House, Chicago, Ill., May 16–19, 1960.

Full particulars may be obtained from the Executive Secretary, William P. Didusch, 1120 North Charles Street, Baltimore, Md. Essays must be in his hands before Dec. 1, 1959.

AMERICAN CANCER SOCIETY

The feature of the Annual Scientific Session of the American Cancer Society to be held Oct. 26–27, 1959, at the Biltmore Hotel, New York, N. Y., will be a Symposium on Evaluation of Early Diagnosis of Cancer.

QUEENS HOSPITAL CENTER

A course in Radioactive Isotopes for Technicians, with emphasis on laboratory technics, is being offered by the Queens Hospital Center, Department of Hospitals, City of New York. It will comprise eight sessions of four hours each, to be held Wednesday afternoons (1 to 5 P.M.) commencing Sept. 30, 1959, and ending Nov. 25, 1959. Sessions will be divided equally between lectures and laboratory work. Enrollment is limited to ten. Tuition for the course is $100.00.

Requests for applications should be sent to Dr. Philip Kahan, Supervising Medical Superintendent, Queens Hospital Center, 82-68 164th St., Jamaica 32, N. Y.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE ESSENTIALS OF ROENTGEN INTERPRETATION. By LESTER W. PAUL, M.D., Professor of Radiology and Chairman of the Department of Radiology, The University of Wisconsin Medical School, and JOHN H. JUHL, M.D., Associate Professor of Radiology, The University of Wisconsin Medical School. A volume of 840 pages, with 1,203 illustrations. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, New York 16, N. Y., 1959. Price $25.00.

X-RAY AND RADIUM IN DERMATOLOGY. By BERNARD A. WANSKER, M.D., Diplomate, American Board of Dermatology, Charlotte, North Carolina; formerly, Instructor in Dermatology, Duke University School of Medicine, Durham, North Carolina. Publication Number 349, American Lecture Series. A monograph of 114 pages, with 20 figures and 12 tables. Published by Charles C Thomas, Springfield, Ill., 1959. Price $5.00.

TUMORS OF THE URINARY BLADDER. By NATHAN B. FRIEDMAN, M.D., Director, Division of Laboratories, Cedars of Lebanon Hospital, Los Angeles, California; Clinical Professor of Pathology, University of Southern California School of Medicine; Consultant in Pathology, Los Angeles County General Hospital, and JAMES E. ASH, M.D., Colonel, U.S.A. (Retired); Former Director, Armed Forces Institute of Pathology, Washington, D. C.; Director of Laboratories, Suburban Hospital, Bethesda, Md. Atlas of Tumor Pathology, Section VIII—Fascicle 31a. A monograph of 84 pages, with 3 color plates and 86 photomicrographs. Published by the Armed Forces Institute of Pathology under the auspices of the Subcommittee on Oncology of the Committee on Pathology of the Division of Medical Sciences of the National Academy of Sciences—National Research Council, Washington, D. C., 1959.

For sale by the American Registry of Pathology, Armed Forces Institute of Pathology, Washington 25, D. C. Price $1.00.

RADIATION BIOLOGY AND MEDICINE: SELECTED REVIEWS IN THE LIFE SCIENCES. Edited by WALTER D. CLAUS, Division of Biology and Medicine, U.S.A.E.C. Prepared for the United States Atomic Energy Commission. A volume of 944 pages, with numerous figures and tables. Published by Addison-Wesley Publishing Company, Inc., Reading, Mass., 1958. Price $11.50.

INDEMNIFICATION OF ATOMIC ENERGY ACTIVITIES AND OPERATIONS OF ADVISORY COMMITTEE ON REACTOR SAFEGUARDS, 1958–1959. Report to the Joint Committee on Atomic Energy on Operations under Section 170 of The Atomic Energy Act of 1954 as Amended. A brochure of 74 pages. Published by United States Atomic Energy Commission, Washington 25, D. C., 1959.

EXPERT COMMITTEE ON HEALTH STATISTICS. SIXTH REPORT INCLUDING THIRD REPORT OF THE SUB-COMMITTEE ON CANCER STATISTICS. World Health Organization Technical Report Series No. 164. A pamphlet of 44 pages. Published by World Health Organization, Palais des Nations, Geneva, Switzerland, 1959. For sale in U. S. A. by Columbia University Press, International Documents Service, 2960 Broadway, New York 27, N. Y. Price 30 cents.

AN INTRODUCTION TO ELECTRONICS FOR PHYSIOLOGICAL WORKERS. By I. C. WHITFIELD, D.Sc., Reader in Physiology, University of Birmingham, England. A volume of 264 pages, with numerous figures. Published by Macmillan & Co. Ltd., London, England; St. Martin's Press, New York, 2d ed., 1959. Price $3.75.

DOSE DISTRIBUTIONS IN ARC THERAPY IN THE 200 TO 250 KV RANGE: SYSTEMATIC MEASUREMENTS IN HOMOGENEOUS PHANTOMS WITH THE BEAM DIRECTION PERPENDICULAR TO THE OSCILLATION AXIS. By OLOV DAHL AND KARL JOHAN VIKTERLÖF, Radiumhemmet and the Institute of Radiophysics, Karolinska Sjukhuset, Stockholm 60, Sweden. Text in English and German. Supplement 171 to Acta radiologica. A volume of 250 pages, with 157 isodose charts, 24 figures, and 19 tables. Published by Acta radiologica, Stockholm 2, Sweden, 1958. Price Sw. Kr. 35:—

DISAPPEARANCE MEASUREMENTS: THEORETICAL, TECHNICAL, BIOLOGICAL AND MEDICAL ASPECTS. By ERIK ODEBLAD, BJÖRN WESTIN, AND SVEN ERIK ENGLUND. From the Isotope Laboratory, Department of Obstetrics and Gynaecology, Sabbatsberg Hospital, Karolinska Institutet, Stockholm, Sweden. Acta radiol. Suppl. 173. A monograph of 78 pages, with 21 figures and 7 tables. Published by Acta radiologica, Stockholm 2, Sweden, 1959. Price Sw. Kr. 30:—

SLIPPING EPIPHYSIS OF THE HIP: A ROENTGENOLOGICAL AND CLINICAL STUDY BASED ON A NEW ROENTGEN TECHNIQUE. By LARS BILLING AND ERIK SEVERIN. From the Department of Orthopedic Surgery, University of Gothenburg, Sweden. Acta radiol. Suppl. 174. A monograph of 76 pages, with 40 figures. Published by Acta radiologica, Stockholm 2, Sweden, 1959. Price Sw. Kr. 35:—

STUDIES ON THE DISTRIBUTION AND FATE OF C^{14} AND T-LABELLED p-AMINOSALICYLIC ACID (PAS) IN THE BODY. By ÅKE HANNGREN. From the Department of Medicine, Karolinska Sjukhuset, Stockholm, and from the Department of Pharmacology, Kungl. Veterinärshögskolan, Stockholm. Acta radiol. Suppl. 175. A monograph of 118 pages, with 53 figures and 10 tables. Published by Acta radiologica, Stockholm 2, Sweden, 1959. Price Sw. Kr. 25:—

CINERADIOGRAPHIC STUDIES ON THE FALLOPIAN TUBES IN RABBITS. By LARS BJÖRK. From the Department of Diagnostic Radiology, University Hospital, Uppsala, Sweden. Acta radiol. Suppl. 176. A monograph of 54 pages, with 13 figures. Published by Acta radiologica, Stockholm 2, Sweden, 1959. Price Sw. Kr. 25:—

ANGEWANDTE UND TOPOGRAPHISCHE ANATOMIE: EIN LEHRBUCH FÜR STUDIERENDE UND ÄRZTE. By Professor Dr. G. TÖNDURY, Direktor des Anatomischen Instituts der Universität Zürich. A volume of 578 pages, with 411 figures. Published by Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 2d ed., 1959. Distributed in the U. S. A. and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 79—($18.80)

Book Reviews

THERAPEUTIC RADIOLOGY: RATIONALE, TECHNIQUE, RESULTS. By WILLIAM T. MOSS, M.D., Assistant Professor of Radiology, Northwestern University School of Medicine, Department of Radiology, Chicago, Ill.; Director, Department of Therapeutic Radiology, Chicago Wesley Memorial Hospital; Chief, Department of Therapeutic Radiology, Veterans Administration Research Hospital, Chicago, Ill. With Foreword by Lauren V. Ackerman, M.D. A volume of 402 pages, with 146 figures. Published by The C. V. Mosby Company, St. Louis, Mo., 1959. Price $12.50.

For several years there has been a serious lack of a

modern American textbook in radiation therapy. This lack has been especially felt by those training residents in this field, and the advent of this new effort is thus more appreciated. This book is wholly written by Dr. Moss himself, and therefore does not have the inconsistencies of therapeutic approach and philosophy so often present in compendia written by several authors. This consistency of approach and presentation is of particular value to the student, since it gives him a point of departure from which to evaluate the multitude of opinions expressed in the literature.

After a brief discussion of the principles governing the use of radiation, the author gives a systematic discussion of the various human tumors of importance in radiation therapy, arranged regionally. In each section there is a presentation of the general characteristics of the tumors, the indications for irradiation and surgery and their relative merits, the technic that can be used, and the results to be expected. A novel feature, and one to be commended, is the discussion of reaction of the normal tissues, in the region under consideration, to irradiation. This is not a recipe book for the practice of radiotherapy and, while the general technical principles are well presented, detailed procedures are not covered. Controversial topics are fairly presented and practical solutions are given for their management.

The opinions presented in this volume are sound and well reasoned. The general approach of the author is conservative and, while differences of opinion could be found on some points, this does not detract from the value of the book. It can be heartily recommended as a textbook for students of radiation therapy whether at the level of the resident or the practicing radiologist, both on its own merits and as the only recent American book of its type.

MODERN TRENDS IN DISEASES OF THE VERTEBRAL COLUMN. Edited by REGINALD NASSIM, B. M., F.R.C.P., Physician to St. George's Hospital, Physician to the Royal National Orthopaedic Hospital, London, and H. JACKSON BURROWS, M.D., F.R.C.S., F.R.A.C.S., Orthopaedic Surgeon to St. Bartholomew's Hospital, and to the Royal National Orthopaedic Hospital; Dean, Institute of Orthopaedics, British Postgraduate Medical Federation (University of London); Consulting Orthopaedic Surgeon to the Royal Navy. A volume of 304 pages, with 172 figures. Published by Paul B. Hoeber, Inc., New York, 1959. Price $15.00.

This volume on the spine and its diseases is the work of fifteen writers, most of them British orthopedists, each being responsible for one chapter. The editors also are primarily interested in orthopedics, so that it is natural that the chief emphasis should be in that field. A chapter on Radiology is contributed by L. S. Carstairs, Radiologist at the Royal Northern Hospital, London, and Dr. Norman Higinbotham of Memorial Hospital, New York, has furnished a brief chapter on Spinal Biopsy.

As is almost unavoidable with multiple authorship, there is some overlapping of the various chapters. The work contains much that is not of immediate interest to the radiologist, though the anatomical discussions may no doubt be read with profit.

MEDIZINISCHE RÖNTGENTECHNIK: LEHRBUCH FÜR MEDIZINISCH-TECHNISCHE ASSISTENTINNEN, ÄRZTE UND STUDIERENDE IN ZWEI TEILEN. Edited by Prof. Dr. HERBERT SCHOEN, Karlsruhe, with the assistance of Dipl.-Physiker Dr. ERICH BUNDE, Munich, Priv.-Doz. Dr. WALTER FROMMHOLD, Berlin, Dr. VIKTOR LOECK, Munich, and Dr. DETLEV SCHOEN, Tübingen. II. PHYSIKALISCH-TECHNISCHER TEIL. 1. GRUNDLAGEN DER STRAHLENDIAGNOSTIK UND STRAHLENTHERAPIE (MIT APPARATEKUNDE). By ERICH BUNDE, Dipl.-Physiker, Munich. 2. RÖENTGENOPHOTOGRAPHIE. By Dr. VIKTOR LOECK, Munich. Second edition. A volume of 464 pages, with 281 figures. Published by Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 1958. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 48—($11.40)

Since the authors of this volume are directing their attention to the practicing technician, the technical instructor, and the working radiologist, this work has greater breadth but less depth than the usual text on x-ray physics. Emphasis is placed on the roentgen apparatus itself, its ancillary equipment, and its daily usage. Profundities of theory, niceties of mathematics, and detailed physical analyses are not included. The subject matter complements the roentgen technic of Volume I (reviewed in RADIOLOGY **68**: 744, 1957).

The topical arrangement is logical with an opening chapter on the fundamentals of electricity. An especially complete chart of the electromagnetic spectrum is followed by a glossed chapter on atomic physics, in which most of the mathematics is omitted, and a basic discussion of the characteristics and qualities of the roentgen ray. In accordance with their expressed aims the authors set forth in detail the geometry of the roentgen image, cassette construction, the effects of intensifying screens, and the operation of the x-ray tube. One may here review the sundry machine circuits, grid structure with its principles, stereoscopy, tomography, and kymography.

Of interest to the therapy technician are the subjects of radioactivity, the handling of radioactive materials, and dosage measurement. These are presented along with the biologic effects of radiation and paragraphs on the practical details of radiation protection.

The final portion of the text, although entitled

roentgenphotography, is actually concerned only with the conventional roentgenogram. Film structure, emulsion composition, density, contrast, definition, and sharpness are the center of study. In the closing pages are good illustrations of common film defects with explanations of the causes.

This is a sturdily bound book on good quality paper with sharp reproductions. It should prove valuable not only to the technician but also to those working in x-ray sales and in machine maintenance.

NORMALE UND PATHOLOGISCHE ENTWICKLUNG DES MENSCHLICHEN HERZENS: URSACHEN UND MECHANISMEN TYPISCHER UND ATYPISCHER HERZFORMBILDUNGEN DARGESTELLT AUF GRUND NEUER BEFUNDE. By Priv.-Doz. Dr. KLAUS GOERTTLER, Pathologisches Institut der Universität Kiel. Heft 3, Zwanglose Abhandlungen aus dem Gebiet der normalen und pathologischen Anatomie. A monograph of 124 pages, with 54 figures. Published by Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 1958. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 33—($7.85)

The understanding of either a normal or a pathologic event in cardiac development requires the observer to separate in his mind some of the building blocks of the growth mosaic and from these visualize the dynamics of the event. The author of this volume has attempted in earlier publications to analyze the general principles of heart development. For the present thesis additional methods of study have been instituted: a review of recent research in heart anatomy, hydraulic experiments with glass models of embryonic hearts, and careful study of pathologic human hearts from a private collection.

Modern investigations indicate that the anlage of the heart is a single and complete unit. Upon this unit, the primitive myocardial tube, metamere formation, septation, lengthening, and bending take place with appropriate timing. Moreover the venous and arterial parts of the heart develop as mirror images of each other in a process which is related intimately with more distant angiogenesis. Because of the multiplicity of time and anatomic factors, serial cardiac sections cannot be analyzed separately.

An hypothesis is presented that in the primitive vertebrate heart a true qualitative difference divides the blood stream between the greater and the lesser circulations, and that the crossing of the aorta and the pulmonary artery is not the primary cause of the independence of the two circulations. The adult division in which the blood interchange is retained is attributed to the cranial location of the pulmonary veins, the obliteration of certain somatic venous anastomoses, and the growth of the cavopulmonic system. There is a phylogenetic basis for this thesis in regard to lung and heart development.

The principal reason for a heart malformation lies in an arrest of growth by either an endogenous or exogenous factor. The type of anomaly which results depends upon the time, the portion of the heart which happens to be metabolically most active, and the intensity of the noxious influence. Embryonal, fetal, and postnatal diseases may be differentiated. The author also divides disorders into those which occur before septum formation is completed and those which occur later. The former group yields gross anomalies with a persistent primitive cardiac structure. The latter group, that of the secondary arrests, includes the dextrocardias, transposition of the great vessels, and improper arterial ostia. Too, one may see combined anomalies, such as Ebstein's and Fallot's.

A monograph of limited scope such as this has a very modest application in ordinary radiologic practice. It is a must book, on the other hand, for the roentgen academician and for anyone definitively studying the human heart.

TECHNIQUE RADIOLOGIQUE: GUIDE DU MANIPULATEUR; THÉORIE ET PRATIQUE. By J. REBOUL, Professeur de clinique électro-radiologique à la Faculté de Médecine de Bordeaux; R. GUICHARD, Electro-radiologiste des hôpitaux de Bordeaux; CH. WANGERMEZ, Ancien professeur à la Faculté de Médecine, Radiologiste des hôpitaux de Bordeaux; J. DUHAMEL, Professeur agrégé de Physique médicale à la Faculté de Médecine de Bordeaux; G. DELORME, Assistant d'électroradiologie des hôpitaux de Bordeaux, Professeur agrégé d'électroradiologie á la Faculté de Médecine. Preface by Dr. Aujaleu, Directeur général de la Santé Publique. A monograph of 216 pages, with 158 figures. Published by Masson & Cie, 120, Boulevard St.-Germain, Paris 6°, 1958. Price 2,400 francs.

Radiologic technicians in France have no official diploma, certificate, or other means to guarantee their qualification. Professor Reboul and his associates have given a course of instruction during the past ten years to the technicians of Bordeaux. It was thought that by making a small textbook they would have something to serve as a basic standard of qualification for technicians. The result is this slender volume containing basic instruction in electricity, the physics of radiology, photographic technic, radiotherapy, and anatomy and positioning. It is this last aspect to which the greatest space is devoted.

The entire text is illustrated by means of rather simple line drawings. These are excellent but it might be well if a few radiographs were reproduced to correlate with the drawings, to show the technician an acceptable final result.

Since there are relatively few technicians in the United States who read French, it is doubtful whether this text will have wide acceptance here.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, Robert L. Brown, M.D., Robert Winship Clinic, Emory University, Atlanta, 22, Ga.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, C. Allen Good, M.D., Rochester, Minn.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

AMERICAN CLUB OF THERAPEUTIC RADIOLOGISTS. *Secretary*, Juan A. del Regato, M.D., 2200 North Cascade Ave., Colorado Springs, Colo.

ASSOCIATION OF UNIVERSITY RADIOLOGISTS. *Secretary-Treasurer*, Paul A. Riemenschneider, M.D., 736 Irving Ave., Syracuse 10, N. Y.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, T. Leucutia, M.D., 10 Peterboro, Detroit 1, Mich.

SOCIETY OF NUCLEAR MEDICINE. *Secretary*, Robert W. Lackey, M.D., 452 Metropolitan Bldg., Denver 2, Colo.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Garland Wood, Jr., M.D., Medical College of Alabama, Birmingham 3.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 1313 N. Second St., Phoenix. Annual meeting with State Medical Association; interim meeting in December.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. B. Scruggs, M.D., 1700 W. 13th St., Little Rock. Meets quarterly.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, William H. Graham, M.D., 630 E. Santa Clara St., San Jose.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, Robert B. Engle, M.D., St. Luke Hospital, Pasadena. Meets second Wednesday, September, November, March, April, and June, Los Angeles County Medical Association Building.

NORTHERN CALIFORNIA RADIOLOGICAL SOCIETY. *Secretary*, Rob H. Kirkpatrick, M.D., 1219 28th St., Sacramento 16. Meets last Monday of each month, September through June.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association convention.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA. *Secretary-Treasurer*, Joseph F. Linsman, M.D., 436 N. Roxbury Dr., Beverly Hills.

REDWOOD EMPIRE RADIOLOGICAL SOCIETY. *Secretary*, Lee E. Titus, M.D., 164 W. Napa Street, Sonoma, Calif. Meets second Monday every other month.

SAN DIEGO RADIOLOGICAL SOCIETY. *Secretary* Stanley A. Moore, M.D., 2466 First Ave., San Diego 1. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, M. A. Sisson, M.D., 450 Sutter St., San Francisco 8. Meets quarterly, at Grison's Steak House.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary*, Stanford B. Rossiter, M.D., 1111 University Dr., Menlo Park. Meets second Wednesday every month.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, John H. Heald, M.D., 450 Sutter St., San Francisco 8. Meets third Thursday at 7:30 P.M., Children's Hospital, September through June.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Lorenz R. Wurtzebach, M.D., 601 E. Nineteenth Ave., Denver 5. Meets monthly, third Friday, at Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary-Treasurer*, Ralph J. Littwin, M.D., Bristol Hospital, Bristol. Meets bimonthly, second Wednesday.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary-Treasurer*, Charles E. Bickham, Jr., M.D., 1835 Eye St., N.W., Washington 6. Meets third Wednesday, January, March, May, and October, 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary*, John P. Ferrell, M. D., 166 4th Ave., St. Petersburg.

FLORIDA WEST COAST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Joseph C. Rush, M.D., 1501 Jungle, St. Petersburg. Meets third week of October, January, April, and July.

GREATER MIAMI RADIOLOGICAL SOCIETY, *Secretary-Treasurer*, George P. Daurelle, M.D., Jackson Memorial Hospital, Miami 36. Meets monthly, third Wednesday, 8:00 P.M., at Jackson Memorial Hospital.

NORTH FLORIDA RADIOLOGICAL SOCIETY. *Secretary*, Paul A. Mori, M.D., 800 Miami Road, Jacksonville 7. Meets quarterly, March, June, September, and December.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Luther Clements, Jr., M.D., 35 Linden Ave., N.E., Atlanta 8. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George W. Brown, M.D., 317 S. 8th St., Griffin, Ga. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Wm. F. Hamilton, Jr., M.D., University Hospital, Augusta. Meets first Thursday of each month.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary-Treasurer*, Louis L. Buzaid, M.D., The Queen's Hospital, Box 861, Honolulu. Meets third Monday of each month.

Idaho

IDAHO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Charles R. McWilliams, M.D., Twin Falls.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary-Treasurer*, George B. Cahill, M.D., 802 Burns Ave., Flossmoor, Ill. Meets at the Sheraton Hotel, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Stephen L. Casper, M.D., Physicians and Surgeons Clinic, Quincy.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, William Meszaros, M.D., 1825 W. Harrison St., Chicago.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, David E. Wheeler, M.D., 1500 North Ritter, Indianapolis. Meets twice a year, first Sunday in May and during fall meeting of State Medical Association.

TRI-STATE RADIOLOGICAL SOCIETY (Southern Indiana, Northwestern Kentucky, Southeastern Illinois). *Secretary-Treasurer*, James R. Mathews, M.D., 118 S. E. First St., Evansville, Ind. Meets October, January, March, and May.

Iowa

IOWA RADIOLOGICAL SOCIETY. *Secretary*, James T. McMillan, M.D., 1104 Bankers Trust Bldg., Des Moines. Meets during annual session of State Medical Society, and in the Fall.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Lewis G. Allen, M.D., 807 Huron Bldg., Kansas City, Kans. Meets in the Spring with the State Medical Society and in the Winter on call.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert H. Akers, M.D., VA Hospital, Louisville 2. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets second Tuesday of each month.

RADIOLOGICAL SOCIETY OF LOUISIANA. *Secretary-Treasurer*, Seymour Ochsner, M.D., Ochsner Clinic, New Orleans 15.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, W. R. Harwell, M.D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Francis J. O'Connor, M.D., Augusta General Hospital, Augusta. Meets in June, October, December, and April.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary-Treasurer*, James K. V. Willson, M.D., 1100 N. Charles St., Baltimore 1. Meets third Tuesday, September to May.

MARYLAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Albert B. Shackman, M.D., 705 Medical Arts Bldg., Baltimore 1.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary-Treasurer*, Joseph O. Reed, Jr., M.D., 3825 Brush, Detroit 1. Meets first Thursday, October to May, Wayne County Medical Society rooms.

UPPER PENINSULA RADIOLOGICAL SOCIETY. *Secretary*, Arthur Gonty, M.D., Menominee. Meets quarterly.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Donald H. Peterson, M.D., 25 W. Fourth St., St. Paul 2. Meets Fall, Winter, and Spring.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Bernard T. Hickman, M.D., University of Mississippi Medical Center, Jackson. Meets monthly, on third Thursday, 6:00 P.M., at Hotel Edwards, Jackson.

Missouri

GREATER ST. LOUIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Harvey A. Humphrey, M.D., 510 S. Kingshighway, St. Louis 10. Meets on fourth Wednesday, October to May.

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary-Treasurer*, Samuel B. Chapman, Jr., M.D., 830 Argyle Bldg., Kansas City, Mo. Meets last Friday of each month.

Montana

MONTANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Arthur T. Austin, M.D., 104 Doctors Bldg., Billings. Meets annually.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Warren Quinton Bradley, M.D., 206 S. 13th St., Lincoln 8. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England

CONNECTICUT VALLEY RADIOLOGIC SOCIETY. *Secretary-Treasurer*, Paul J. Kingston, M.D., 114 Woodland St., Hartford, Conn. Meets second Friday of October and April.

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, John E. Gary, M.D., 1180 Beacon St., Brookline 46, Mass. Meets third Friday, October through May, Longwood Towers, Brookline, Mass.

New Hampshire

NEW HAMPSHIRE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Paul Y. Hasserjian, M.D., 1470 Elm St., Manchester. Meets three times a year.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Austin J. Tidaback, M.D., 912 Prospect Ave., Plainfield. Annual meeting in Spring, Atlantic City; Fall meeting October or November, Newark.

New York

BROOKLYN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George A. Manfredonia, M.D., One Hanson Place, Brooklyn. Meets first Thursday of each month.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary*, Alfred H. Dobrak, M.D., 108 Pine St., Buffalo. Meets second Monday, October to May.

CENTRAL NEW YORK RADIOLOGICAL SOCIETY. *Secretary*, Joseph A. Head, M.D., University Hospital, 150 Marshall St., Syracuse. Meets first Monday, October through May.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, C. P. Naidorf, M.D., 411 Parkside Ave., Brooklyn 26. Meets fourth Thursday, October to April (except December), at 9:00 P.M., Kings County Medical Bldg.

NASSAU RADIOLOGICAL SOCIETY. *Secretary*, Jerome Zwanger, M.D., 126 Hicksville Road, Massapequa. Meets second Tuesday, February, April, June, October, and December.

NEW YORK ROENTGEN SOCIETY. *Secretary*, William B. Seaman, M.D., 622 W. 168th St., New York 32, N. Y.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Irving Van Woert, Jr., M.D., Albany Hospital, Albany. Meets in the capital area second Wednesday, October, November, March, and April; annual meeting, May or June.

RADIOLOGICAL SOCIETY OF STATE OF NEW YORK. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meets annually with the State Medical Society.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, Theodore F. VanZandt, M.D., 501 W. Main St., Rochester 8. Meets last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Arnold Myron Wald, M.D., 406 Boston Post Road, Port Chester. Meets third Tuesday of January and October and as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary-Treasurer*, Charles Bream, M.D., North Carolina Memorial Hospital, Chapel Hill, N.C. Meets in spring and fall of each year.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Marianne Wallis, M.D., Minot. Meets in the Spring with State Medical Association; in Fall or Winter on call.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary*, Paul D. Meyer, M.D., 125 S. Grant Ave., Columbus. Next annual meeting, Cincinnati, May 1959.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, William B. Schwartz, M.D., 1500 W. Third Ave., Columbus 12. Meets second Thursday, October, November, January, March, and May, 6:30 P.M., Fort Hayes Hotel, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Frederick A. Rose, M.D., 2065 Adelbert Road, Cleveland 6. Meets at 7:00 P.M., fourth Monday, October, November, January, February, March, and April, at Tudor Arms Hotel.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John E. Singer, M.D., 19 Garfield Pl., Cincinnati 2. Meets first Monday, September through May, at Cincinnati General Hospital.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, G. F. Johnson, M.D., 1030 Reibold Bldg., Dayton 2, Ohio. Meets monthly, second Thursday, Miami Valley Hospital. Dayton.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary*, J. Murphree, M.D., 617 E. Brookfield, Ponca City.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, C. V. Allen, M.D., 9855 S.W. Hawthorne Lane, Portland. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club, Portland.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Arch Colbrunn, Jr., M.D., 164 W. Tanager St., Roseburg, Ore. Next annual meeting in Vancouver, B. C., in May 1960.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Walter P. Bitner, M.D., 234 State St., Harrisburg. Next annual meeting, May 14–15, 1960, Pocono Manor.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Robert B. Funch, M.D., Germantown Hospital, Philadelphia 44. Meets first Thursday of each month at 5:00 P.M., from October to May, in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary*, Charles N. Chasler, M.D., Elizabeth Stesl Magee Hospital, Pittsburgh, 13. Meets monthly, second Wednesday, October through June, Park Schenley Restaurant.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John H. Freed, M.D., 4200 E. Ninth Ave., Denver 20, Colo. Next annual meeting, Aug. 20–22, 1959, Shirley-Savoy Hotel, Denver.

South Carolina

SOUTH CAROLINA RADIOLOGICAL SOCIETY. *Secretary*, Wayne Reeser, M.D., 1600 Ninth Ave., Conway. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Donald J. Peik, M.D., 303 S. Minnesota Ave., Sioux Falls. Meets during annual meeting of State Medical Society.

The Southeast

Southern Radiological Conference. *Secretary-Treasurer*, Marshall Eskridge, M.D., 1252 Springhill Ave., Mobile, Ala.

The Southwest

SOUTHWESTERN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Gordon L. Black, M.D., 1501 Arizona Bldg., El Paso, Texas.

Tennessee

EAST TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Charles W. Reavis, M.D., Baroness Erlanger Hospital, Chattanooga. Meets in September and January, and prior to State Medical Association meeting.

MEMPHIS ROENTGEN SOCIETY. *Secretary-Treasurer*, Hollis H. Halford, M.D., Kennedy VA Hospital, Memphis 15. Meets monthly first Monday, John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James J. Range, M.D., P. O. Box 324, Johnson City. Meets annually with State Medical Association in April.

Texas

CENTRAL TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Glenn Addison Stokdyk, M.D., VA Center, Temple. Meets monthly, fourth Monday, at Kosel's Cafe, Temple.

DALLAS-FORT WORTH RADIOLOGICAL CLUB. *Secretary*, Albert H. Keene, M.D., 3707 Gaston Ave., Dallas. Meets monthly, third Monday, 6:30 P.M., at the Greater Fort Worth International Airport.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Edward Singleton, M.D., 6621 Fannin St., Houston 25. Meets last Monday of each month at the Doctors' Club.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY. *Secretary*, Hugo F. Elmendorf, Jr., M.D., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets at Fort Sam Houston Officers' Club, third Wednesday of each month, 6:30 P.M.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 1216 Pennsylvania Ave., Fort Worth 4. Next meeting in Houston, Jan. 22–23, 1960.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Wm. R. Christensen, M.D., 2033 S. State St., Salt Lake City 5. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, Frank A. Kearney, 2nd, M.D., 110 S. Curry St., Phoebus.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Wayne A. Chesledon, M.D., 306 Stimson Bldg., Seattle 1. Meets fourth Monday, September through April, at College Club, Seattle.

West Virginia

WEST VIRGINIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Karl J. Myers, M.D., 112 N. Woods St., Philippi. Meets with State Medical Society, and as arranged by Program Committee.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Joseph F. Wepfer, M.D., 5000 W. Chambers St., Milwaukee 10. Meets fourth Monday, October through May, at the University Club.

SECTION ON RADIOLOGY, STATE MEDICAL SOCIETY OF WISCONSIN. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee 2. Meets in October with State Medical Society.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Farrell F. Golden, M.D., 5221 Tonyawatha Trail, Madison 4.

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary-Treasurer*, Dr. R. B. Díaz Bonnet, Suite 504, Professional Bldg., Santurce, P.R.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, Robert G. Fraser, M.D.; *Associate Honorary Secretary-Treasurer*, Jean-Louis Leger, M.D. *Central Office*, 1555 Summerhill Ave., Montreal 25, Quebec. Meets in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALES. *General Secretary*, Louis Ivan Vallée, M.D., Hôpital Saint-Luc, 1058 rue St-Denis, Montreal 18. Meets third Saturday of each month.

L'ASSOCIATION DES RADIOLOGISTS DE LA PROVINCE DE QUEBEC. ASSOCIATION OF RADIOLOGISTS OF THE PROVINCE OF QUEBEC. *Secretary*, O. Raymond, M.D., 5400 Blvd. Gouin W., Montreal 9. Meets four times a year.

MONTREAL RADIOLOGICAL STUDY CLUB. *Secretary*, Douglas W. MacEwan, M.D., 2300 Tupper St., Montreal 25, Quebec. Meets first Tuesday evening, October to April.

TORONTO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, L. R. Harnick, M.D., X-Ray Department, Toronto Western Hospital, 399 Bathurst St. Meets second Monday evening, September to May.

CUBA

SOCIEDAD CUBANA DE RADIOLOGÍA Y FISIOTERAPIA. *Secretary*, Dr. Miguel A. García Plasencia, Hospital Curie, 29 y F, Vedado, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA. *Headquarters*, Calle de Coahuila, Núm. 35, Mexico 7, D. F. *Secretary General*, Dr. Jorge Ceballos Labat. Meets first Monday of each month.

PANAMA

SOCIEDAD RADIOLÓGICA PANAMEÑA. *Secretary-Editor*, Luis Arrieta Sánchez, M.D., Apartado No. 86, Panama, R. de P.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Intracranial Pneumoplanigraphy in the Verticosubmental Position. A Neuroroentgenographic Refinement. W. Eugene Stern, William Hanafee, and Stefan Wilk. Neurology **8:** 596–600, August 1958. (W. E. S., Department of Surgery, University of California Medical Center, Los Angeles, Calif.)

This paper describes a combination of standard pneumoencephalography or ventriculography with horizontal planigraphy. After the cerebrospinal fluid has been replaced by gas in the usual way, the patient is placed in the prone position on the laminagraphic table, with the head and neck moderately extended (verticosubmental position). The nasion-external auditory meatal line is brought parallel to the table top by means of a soft adjustable pad under the chin. The laminagraphic "cuts" thus parallel the undersurface of the cerebral hemispheres. Four to eight films are made. Positioning may be difficult in those patients with short, thick necks or with cervical spine disease.

To provide examples of normal radiologic anatomy, two normal formalin-hardened brains were imbedded in gelatin and air was introduced into the ventricles. Horizontal laminagraphic "cuts" were made and compared with photographs of 1-cm. slices of these brains. Four illustrations depict the radiographic anatomy at 4, 5, 6, and 7 cm. above the base-line plane.

This technic permits a view of the ventricular, cisternal, and subarachnoid shadows in a projection familiar to the anatomist and most helpful to the clinician. A case is presented as an example of the useful definition of pathologic alterations in a structure difficult to visualize by more standard technics. A girl of six and one-half years had a left hemiparesis which had been present since shortly after birth. Routine pneumographic views showed ventricular dilatation on the right. Horizontal planigrams demonstrated shrinkage of the right cerebral peduncle, further supporting the clinical deficit.

Seven roentgenograms; 2 photographs.

EUGENE A. CORNELIUS, M.D.
Houston, Texas

The Significance of Subdural Air in Pneumoencephalograms in Infants. Robert P. Boudreau and R. M. N. Crosby. Am. J. Roentgenol. **80:** 429–435, September 1958. (University Hospital, Baltimore 1, Md.)

Early diagnosis and treatment of subdural effusions in infants are of importance since, unless treated promptly, they almost invariably result in generalized debility and neurologic disorders, such as convulsions, disturbed motor function, and mental retardation.

The authors sought to determine if the demonstration of subdural air on the pneumoencephalogram could in any way contribute to a diagnosis of effusion. They examined 159 pneumoencephalograms of children under two years of age, and found that 66 or 41 per cent showed the presence of subdural air in some form. Six of these were excluded as they were not verified by operation. The remainder were divided into three groups.

Thirty-five fell into Group I, showing a considerable amount of subdural air overlying the cerebral hemispheres, freely movable over the convexities of the hemispheres as seen on films taken in suitable positions; 33 or 94 per cent of these had a subdural effusion or membrane.

Seventeen cases fell into Group II, showing a small amount of subdural air overlying the cerebral hemispheres, which was not freely movable. Only 6 children in this group were found to have subdural collections on trephination and craniotomy.

Subdural air outlining the tentorium or falx (Group III) was of no significance in the search for subdural effusion.

From these observations it is concluded that in the infant under two years of age subdural air is pathognomonic of a subdural effusion in those cases which fall into Group I; it must be considered of questionable importance in cases of Group II, being regarded as significant until proved otherwise. No conclusions concerning the diagnostic value of subdural air in adult pneumoencephalography can be deduced from this study.

Eight roentgenograms; 2 tables.

FREIDOUN ESKANDARI, M.D.
Cleveland Metropolitan General Hospital

Glioblastoma Multiforme. Review of 219 Cases with Regard to Natural History, Pathology, Diagnostic Methods, and Treatment. Saul A. Frankel and William J. German. J. Neurosurg. **15:** 489–503, September 1958. (Department of Surgery, Yale University School of Medicine, New Haven, Conn.)

An unselected series of 219 cases of glioblastoma multiforme was reviewed from the standpoint of natural history of the disease, diagnostic studies, treatment, and pathology.

Natural History: Fifty-eight per cent of the patients were males and 42 per cent females. The incidence was greatest in the fifth and sixth decades. The total duration of the disease was under a year in 67 per cent of the cases; 11 per cent of the patients lived two to five years. Headache was the most frequent and seizures the second most frequent initial complaint.

Diagnostic Studies: The cerebrospinal fluid is almost always abnormal in some respect. However, because of a 2 per cent mortality for the procedure, and because of nonspecificity of the information obtained, routine lumbar puncture is not recommended.

Skull roentgenograms were abnormal in 59 per cent of the cases; 32 per cent showed pineal shift; in 26 per cent there were changes secondary to increased intracranial pressure; 2 per cent showed abnormal calcification; 9 per cent various other abnormalities.

Electroencephalograms were obtained in 90 cases and were abnormal in 93 per cent; they localized the lesion correctly in 49 per cent.

Pneumoencephalography was done only 19 times, with 1 fatality. The lesion was localized in only 3 cases.

Ventriculograms gave a correct localization in 77 per cent of 131 cases. Craniotomy was usually performed the same day. The fact that no localization was obtained in 23 per cent of the cases emphasizes the importance of having an accurate history and neurological examination before becoming committed to surgery.

Arteriography was performed in only 21 cases, the series antedating the present vogue for this procedure. Localization was correct in 48 per cent of the number.

Treatment: In 183 patients treated surgically, the average postoperative survival time was about three

months. The more radical surgical measures offered the best prognosis.

Twenty-one patients received a complete course of radiotherapy within sixty days after operation. The tumor dose was in the range of 2,700–5,900 r. This group showed a significantly higher percentage of survivors during the first year than a group which had been treated by surgery alone. With a single exception, those patients surviving nine months or more received over 4,000 r tumor dose.

The effect of all present forms of treatment is to prolong life by three to six months. Long-term survivals are just as common among untreated patients as among those treated. There were no cures.

Pathology: The frontal, temporal, and parietal lobes were involved with about the same frequency and together accounted for most of the cases. Growths arising in midline structures were relatively rare. Microscopic calcification was present in 7 per cent and gross calcification in 3 per cent of the tumors.

Eight figures; 5 tables.

EUGENE A. CORNELIUS, M.D.
Houston, Texas

Hemangioma of the Skull Associated with Intracranial Angioma. Labe Scheinberg and Milton Elkin. Neurology **8:** 650–652, August 1958. (Albert Einstein College of Medicine, New York, N. Y.)

The authors report a case of hemangioma of the skull associated with an angioma of the brain. The patient was a 42-year-old female admitted because of sudden onset of dizziness, vomiting, and lethargy. Recurrent occipital headaches had been experienced for many years. Physical examination revealed nuchal rigidity, a bruit over the left eyeball, and a right homonymous hemianopia. There were 13,500 red blood cells per cubic millimeter of cerebrospinal fluid. Roentgenograms of the skull showed an oval, radiolucent area, about 2.5 cm. in diameter, in the mid-upper occipital bone. Fine stippling and honeycombing were present in this area. The appearance was consistent with hemangioma of the skull. Bilateral carotid angiography revealed a large intracranial angioma in the left parietal region, supplied by several large tortuous vessels arising from the left middle cerebral group. A connection between the angioma and the hemangioma of the skull could not be demonstrated.

It is believed that intracranial angiomas, as well as angiomas in other organs, may in rare instances occur in association with hemangiomas of the skull.

Six roentgenograms.

EUGENE A. CORNELIUS, M.D.
Houston, Texas

Observations on Hemiplegia with Middle Cerebral Artery Trunk Occlusions and with "Normal" Carotid Angiograms. J. E. Webster and E. S. Gurdjian. Neurology **8:** 645–649, August 1958. (1553 Woodward Ave., Detroit 26, Mich.)

In a series of 200 hemiplegic patients, there were 16 (8 per cent) showing occlusion of the middle cerebral artery and 33 (16 per cent) with "normal" angiograms. These two groups were studied from the radiologic, neurologic, and electroencephalographic points of view, and observations were also made on responses to carotid artery compression in the neck.

In the patients with occlusion of the main trunk of the middle cerebral artery (Group 1), the associated hemiplegia was usually uniform and profound, with or without aphasia. The occlusions were due mainly to atherosclerosis rather than to arteriolar sclerosis. Carotid compression usually failed to induce syncope (only 15 per cent).

In the hemiplegic patients with "normal" carotid angiograms (Group 2), also, contralateral carotid compression usually failed to induce syncope. In 3 of the 5 cases in this group which did respond with syncope, the carotid sinus reflex was responsible, and the response was prevented by atropine.

It is difficult to establish the cause of the hemiplegia in the cases with normal carotid angiographic patterns. It may be due to involvement of the smaller arterial branches supplying the internal capsule; a more widespread involvement of the smaller arterial branches of the middle cerebral artery supplying the cortex and the subcortex; single or multiple attacks of cerebrovascular insufficiency, the causes of which are not easily determined; early vertebral-basilar artery occlusive disease before the development of bilateral paralysis; or to an embolus or emboli. Group 2 patients are usually of more advanced age, often with associated chronic hypertension, renal and myocardial disease.

The syncopal state on carotid compression occurs in about 80 per cent of cases of occlusion of the carotid, anterior cerebral, and basilar-vertebral vessels. Therefore, when a well defined hemiplegia is not associated with a syncopal effect on carotid bifurcation compression on the same side as the hemiplegia, a diagnosis of middle cerebral artery trunk occlusion or occlusion of the terminal middle cerebral branches should be considered.

Four roentgenograms; 3 photographs; 2 tables.

EUGENE A. CORNELIUS, M.D.
Houston, Texas

Blood Pressure Changes in Cerebral Arteries During Carotid Angiography with Umbradil. Ulf Söderberg and Nils Weckman. Acta radiol. **50:** 317–320, September 1958. (Karolinska Institutet, Stockholm, Sweden)

Reports have appeared describing a mild, transient reduction of cerebral blood flow following injection of Umbradil (diiodo-pyridone-N-acetic acid), an increase with the use of Triurol (sodium acetrizoate, or Urokon), and no effect with Hypaque (sodium diatrizoate). The current authors undertook to determine whether the effects of Umbradil could be due to vasoconstriction or to a redistribution of blood flow to the extracerebral vessels as a result of vasodilatation in the extracranial tissues.

The pressures in the exposed basilar and femoral arteries of the cat were studied. A rapid fall in pressure in the basilar artery was detected after small doses of Umbradil were injected into the common carotid, some twenty seconds before any change in the systemic (femoral) pressure was disclosed. Since vasospasm does not follow the injection of small amounts of Umbradil into any vessel, it would appear probable that the rapid fall in pressure is to be explained by a redistribution of blood flow from intra- to extracerebral vessels.

Work by others, who have injected Umbradil directly into the muscles, causing vasodilatation, supports the observation that the effects are due to redistribution of blood flow rather than to vasoconstriction.

One figure.

SAUL SCHEFF, M.D.
Boston, Mass.

The Effect of Rotation of the Skull on the Measured Position of the Pineal Gland. John W. Agnos and D. G. Wollin. J. Canad. A. Radiologists **9**: 40–44, September 1958. (Sunnybrook Hospital, Toronto, Ont., Canada)

Using a radiopaque marker simulating the pineal body in skulls of varying configuration and symmetry, the authors determined the effect of rotation on apparent pineal position. Two millimeters displacement from the midline was considered to be within normal limits.

In a dolichocephalic skull there was found to be the least displacement per degree of rotation, so that in this type the permissible rotation was highest, decreasing progressively as one passed to the mesocephalic and the brachycephalic skull. It also varied with the projection used, being greater for the Caldwell view than for the Towne and reverse Caldwell projections.

About 8° of rotation is the maximum that can be accepted in diagnostic work, though in skulls of all three types, whether symmetrical or asymmetrical, the degree of permissible rotation is greater than this in the Caldwell projection.

In the lateral view a rotation of 20° produces no significant change in the position of the pineal. Beyond 15° of rotation the roentgenogram would not be considered acceptable for interpretation.

Because of its position in the skull, the pineal will move in the direction of the external occipital condyle or the lambda rather than the crista galli. In any case in which this does not occur, the pineal is displaced.

Ten figures, including 4 roentgenograms; 1 table.

CAPT. BYRON G. BROGDON, M.C.
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Posterior Fossa Arteriovenous Aneurysm with Occlusion of a Vertebral Artery. Robert D. Teasdall. Neurology **8**: 571–574, July 1958. (Subdepartment of Neurological Medicine, The Johns Hopkins Hospital, Baltimore, Md.)

This is a report of a case of posterior fossa arteriovenous aneurysm, in which occlusion of a parent arterial trunk, a vertebral artery, drew attention to the malformation. No similar case was found in the literature.

In March 1957, a cutaneous arteriovenous aneurysm was removed from the right cheek of a 32-year-old male and the right external carotid artery was ligated. The internal carotid system was normal. On Nov. 11, 1957, the patient was suddenly stricken with unsteadiness, dizziness, nausea, vomiting, impaired speech, and severe pain in the right forehead. Examination revealed cranial nerve involvement from the sixth to the twelfth on the right side, nystagmus, right Horner's syndrome, right cerebellar signs, left hemihypesthesia, and left upper motor neuron signs with sparing of position sense. Ocular findings included impairment of conjugate gaze and anterior internuclear ophthalmoplegia. A bruit was present over the right side of the head. Routine skull plates were normal.

Right common carotid angiography was performed on the tenth hospital day. No external carotid filling occurred. Apart from a few abnormal vessels at the origin of the posterior cerebral artery, the internal carotid system was normal. Right vertebral angiography demonstrated findings suggesting occlusion of that vessel just below the foramen magnum. Right occipital angiography revealed dilated tortuous vessels over the posterolateral aspect of the scalp, but no internal communication. A repeat right vertebral angiogram showed the same block as previously. Left vertebral angiography was then performed, disclosing a massive arteriovenous malformation in the posterior fossa, involving the brain stem and extending fron the foramen magnum to the dorsum sellae, and posteriorly into the cerebellum. Venous drainage was chiefly into the straight sinus. Twelve weeks after onset of the illness, the patient was much improved.

The clinical findings were all compatible with right vertebral artery thrombosis. Although some of the ocular findings were indicative of damage much higher in the brain stem, it seemed reasonable to relate them to the proved occlusive lesion.

Five roentgenograms.

EUGENE A. CORNELIUS, M.D.
Houston, Texas

Intracranial Extension of Tumors of the Ethmoid, Orbit, and Rhinopharynx: Angiographic Study. G. J. Melot, R. Potvliege, J. Brihaye, and Ph. Martin. Acta radiol. **50**: 137–150, July-August 1958. (In French) (Université libre de Bruxelles, Belgium)

Involvement of the frontal fossa by carcinomas of ethmoidal or orbital origin has been reported less often than infiltration of malignant tumors of the nasopharynx toward the base of the skull. This may be due to the later development of clinical signs. The authors used carotid and vertebral angiography as well as pneumography in the study of tumors which were situated at the base of the skull. These procedures aid in demonstrating the intracranial extension of tumors from the ethmoidal, orbital, and nasopharyngeal regions.

Nine roentgenograms.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

Neurological Syndromes Associated with Congenital Absence of the Odontoid Process. L. P. Rowland, J. H. Shapiro, and H. G. Jacobson. Arch. Neurol. & Psychiat. **80**: 286–291, September 1958. (Montefiore Hospital, New York, N. Y.)

Two cases of congenital absence of the odontoid process are reported (and a third is summarized in an addendum). Fifteen cases were collected from the literature.

Symptoms vary considerably. Some patients have only cerebral symptoms, others show signs and symptoms of slowly progressive cervical myelopathy. In 5 cases trauma was followed by transient weakness of the extremities, and 7 patients had cervical pain and torticollis immediately following injury to the neck. Roentgenologically, absence of the odontoid can be demonstrated readily on routine cervical spine study. Tomograms are excellent for precise delineation of the deformity. Films taken in flexion and extension aid in the evaluation of atlanto-axial subluxation which is frequently associated with this condition.

Neurological changes are probably due to direct compression of the cord or embarrassment of its vascular supply. Postmortem studies were performed in only 2 cases. In one, compression of the cord was demonstrated. In the other, platybasia and congenital malformation of the cerebrum were found. In one other patient, laminectomy disclosed adhesive arachnoiditis. The exact nature of the myelopathy is not known in most cases, since they have not been examined anatomically. The possibility exists that absence of the odontoid is a coincidental finding of no pathological sig-

nificance, and that some other neurological disorder is present.

Seven roentgenograms. J. S. ARAJ, M.D.
Toledo, Ohio

Calcification of the Hyoid, Thyroid and Tracheal Cartilages in Infancy; Report of a Case. P. E. Russo and C. G. Coin. Am. J. Roentgenol. **80:** 440–442, September 1958. (University of Oklahoma School of Medicine, Oklahoma City, Okla.)

The authors report a case of calcification of the hyoid, thyroid, and laryngeal cartilages in an infant of three months who had exhibited severe stridor since birth and had experienced several attacks of upper respiratory tract infection. The respiratory difficulty had interfered with nutrition and development. The mother had had German measles during the second month of gestation. Two siblings were found to be normal.

The chest film revealed mild emphysema. The calcified hyoid, thyroid, and laryngeal cartilages were well visualized in a lateral view. All the laboratory data were within normal limits except for elevation of blood phosphorus, which was 6.56 mg. per 100 c.c. of serum.

Re-examination of the patient after seven years showed no change in the amount of calcium deposit in the cartilages, which, however, had developed normally. Apart from some underdevelopment the child was normal.

The case reported lacks the stippled epiphyses and other important characteristics of chondrodystrophia calcificans and probably represents a complication or end-result of a disturbed calcium metabolism not understood at present.

Two roentgenograms.

FREIDOUN ESKANDARI, M.D.
Cleveland Metropolitan General Hospital

THE CHEST

Emphysema and the Lungs of the Aged: A Clinical Study. Preliminary Report. Edgar Mayer, Charles Blazsik, and Israel Rappaport. Dis. of Chest **34:** 247–256, September 1958. (850 Fifth Ave., New York 21, N. Y.)

This preliminary report was presented as the Seventh Howard Lilienthal Lecture at the annual meeting of the New York State Chapter, American College of Chest Physicians, New York City, May 27, 1957. A clinical study of emphysema in aged men and women in progress at that time yielded substantial support of the validity of the authors' concept of senile lung *vs.* senile emphysema. They maintain that in the aged, emphysema is not a prevalent disease. Also, when present, it is no different in the elderly than in the younger age groups.

The changes occurring with aging of the lung, often erroneously identified with emphysema, are rarely recognizable before the age of eighty, and are seen predominantly in women. In those who have led a vigorous active life, particularly men, senile lung changes appear to be delayed or absent. In the truly senile state, pulmonary function seems quite sufficient in view of the reduced activities of the aged. In some cases senile lung changes may predispose to late and rapid onset of emphysema under such pathological conditions as congestive failure or bronchopulmonary infections.

Five roentgenograms. CADMAN CHAFFIN, M. D.
Mercy Hospital, Pittsburgh, Penna.

The Lungs in Scleroderma. E. C. Bonard. Schweiz. med. Wchnschr. **88:** 373–380, April 19, 1958. (In French) (Policlinique universitaire de médecine, Geneva, Switzerland)

Visceral manifestations of scleroderma have been observed with ever increasing frequency in recent years. Knowledge of systemic sclerosis in the gastrointestinal tract, lungs, heart, and kidneys is important, as skin lesions can be completely lacking in spite of advanced changes elsewhere. The author has observed 13 cases, 10 in females and 3 in males, in which fibrotic changes occurred in the lungs, but without typical skin manifestations, except for Raynaud's syndrome and sclerodactylia.

In the early stages the pulmonary markings were accentuated and there was a fine reticular pattern, especially in the lower lung fields. In the moderately advanced stage, fibrotic strands were denser and interwoven in a honeycomb pattern. As the disease progressed, right heart enlargement developed, with consequent respiratory distress. Abnormal electrocardiographic findings suggested involvement of the myocardium by the disease. Three deaths in this series were due to cardiopulmonary insufficiency.

The roentgen diagnosis can be rendered difficult by chronic emphysematous changes obscuring the reticular and fibrotic pattern. Similar difficulties arise when pseudocysts predominate throughout both lungs. Increased radiolucency of the apical fields has been observed in cases with lower lobe involvement.

In the differential diagnosis other collagen diseases must be considered, as Hamman-Rich syndrome, disseminated lupus erythematosus, periarteritis nodosa, and reticuloendotheliosis. Other conditions to be excluded are tuberculosis, sarcoidosis, pneumoconiosis, atypical pneumonia, pulmonary congestion, and disk atelectasis.

Four roentgenograms; 4 tables.

ERNEST KRAFT, M.D.
Northport, N. Y.

Metastatic Pulmonary Melanoma of 15 Months, Duration. Milton B. Rosenblatt and James R. Lisa. Dis. of Chest **34:** 342–344, September 1958. (J. R. L., N. Y. C. Department of Hospitals, New York, N. Y.)

In a radiographic study of 314 metastatic neoplasms of the lungs, Minor (J. Thoracic Surg. **20:** 34, 1950. Abst. in Radiology **56:** 762, 1951) found 15 secondary to melanoma. The average time between the onset of the primary disease and the appearance of the pulmonary lesions was 32.5 months, and the interval between the recognition of the metastasis and death was 4.1 months. In the case reported here, the patient, a man of sixty-one years, lived fifteen months after discovery of the metastases in the lungs. The primary lesion was believed to be in the mouth, but this was not suspected until fourteen months after detection of the pulmonary involvement. Autopsy showed melanoma also in the adrenals, jejunum, ileum, colon, ribs, and brain.

Two roentgenograms; 1 photomicrograph.

CADMAN CHAFFIN, M.D.
Mercy Hospital, Pittsburgh, Penna.

Malformation of the Costal Cartilages. E. Fischer. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 687–690, June 1958. (In German) (Medizinische Strahleninstitut der Universität Tübingen, Germany)

Malformations of the costal cartilages can be roent-

genologically demonstrated only if the cartilages are at least partially calcified. Such malformations include underdevelopment and disturbance in segmentation.

Underdevelopment may manifest itself by a reduction in length or in thickness of the cartilages. In its most extreme degree all or part of all the costal cartilages are absent (*fissura thoracalis parasternalis*).

Segmentation may have been inhibited as in synchondrosis of two cartilages or bridge formation, or it may have been overstimulated as in fork formation of the cartilage or the presence of two cartilages for one rib.

The border between the bony rib and the costal cartilage in the newborn is in the anterior axillary line. During childhood and adolescence this border travels medianward toward the sternum. This development is not always simultaneous in all ribs, so that occasionally one or more ribs may be out of alignment.

During interpretation of chest films the spotty and uneven calcification of the costal cartilages and the possibility of malformation must be kept in mind to avoid mistaking them for pulmonary calcareous deposits.

Seven roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

THE HEART AND BLOOD VESSELS

The Ostium Primum Syndrome. Brian Kiely, Paul Adams, Jr., Ray C. Anderson, and Richard G. Lester. J. Dis. Child. **96:** 381–403, September 1958. (Downstate Medical Center, 450 Clarkson Ave., Brooklyn 3, N. Y.)

Ostium primum syndrome is a complex group of congenital intracardiac anomalies involving malformations of the atrioventricular canal. General features of the syndrome include a defect in the lowest part of the interatrial septum immediately above the atrioventricular valves (ostium primum), a defect in the upper posterior part of the interventricular septum, an apex-to-base cleft of the aortic cusp of the mitral valve, and a similar cleft in the adjacent septal cusp of the tricuspid valve. Theoretically there are fourteen possible combinations of these lesions, each of which is described and discussed in this paper. The literature on ostium primum syndrome is reviewed and the pathology and embryology are described.

It is not at present ordinarily possible to distinguish the various complexes associated with the ostium primum syndrome from one another prior to autopsy or operation. Data are reviewed from 14 cases seen by the authors as well as other previously published material, and an attempt is made to find out whether any of the complexes of the syndrome exhibit features which will allow specific diagnosis. It appears that when the complex includes ostium primum with cleft mitral valve and atrioventricular canal a characteristic syndrome is produced. This is described and illustrated.

For the group as a whole radiographic findings are generally quite nonspecific, including generalized enlargement of the heart, right ventricular hypertrophy, pulmonary artery enlargement, and increased pulmonary vascular markings. Previously published information indicates that a defect at the interventricular septum may be visualized by selective angiocardiographic procedures. Cardiac catheterization data are scanty, but generally show a left-to-right shunt at the atrial level. Occasionally shunts at the ventricular levels are found. Arterial blood has usually been fully oxygen-saturated.

Extensive discussion on the differential diagnosis of this syndrome complex is given and should be read in the original by those interested in congenital heart disease and its surgical correction.

Ten figures, including 3 roentgenograms; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Eisenmenger Syndrome or Pulmonary Hypertension with Reversed Central Shunt. Paul Wood. Brit. M. J. **2:** 701–709, Sept. 20, 1958; 755–762, Sept. 27, 1958. (National Heart Hospital, London, England)

On the basis of an exhaustive study, the author proposes a new definition of the Eisenmenger complex—"pulmonary hypertension at systemic level, due to a high pulmonary vascular resistance (over 800 dynes sec./cm.^{5}), with reversed or bidirectional shunt through a large ventricular septal defect (1.5 to 3 cm. across)." He also proposes to extend the designation to a number of other conditions when these behave physiologically like Eisenmenger's complex. The term thus will include cases of patent ductus, aortopulmonary septal defect, persistent truncus arteriosus, transposition of the great vessels (with ventricular septal defect), corrected transposition (with ventricular septal defect), single ventricle, ventricular septal defect, common atrioventricular canal or persistent ostium primum, single atrium, atrial septal defect, hemi-anomalous and total anomalous pulmonary venous drainage.

The present analysis is based upon 127 cases of Eisenmenger's syndrome, representing 17.5 per cent of 727 cases of congenital heart disease with a communication of some sort between the systemic and pulmonary circulations.

Analysis of case histories indicates that the high pulmonary vascular resistance is established at birth or in infancy in most cases of patent ductus and ventricular septal defect but does not develop until adult life in most atrial septal defects.

Cyanosis, polycythemia, and clubbing were almost always seen in the Eisenmenger complex. Hemoptysis (from pulmonary infarction) is a frequent finding in adult life, being the immediate cause of death in 29 per cent of 42 fatal cases.

Radiographically, the usual findings were dilatation of the pulmonary artery and cardiac enlargement. Peripheral lung vessels ranged from small to large, depending on the volume of flow. A right-sided arch was seen in 16 per cent of the cases but never in association with patent ductus or atrial septal defect.

Pressure relationships and the sites of shunts were readily demonstrated by cardiac catheterization. Dye-dilution curves and/or selective angiocardiography will also usually establish the site and nature of the shunt.

Autopsy findings in 15 cases of this series and 38 from other sources are presented in detail. Next to hemoptysis from infarction as a cause of death was surgery for duct ligation or septal repair. This finding led the author to establish the rule that surgery should not be done unless it could be demonstrated that pulmonary blood flow was twice the systemic flow at rest and that pulmonary resistance exceeded 10 units (800 dynes sec./cm.^{5}). In borderline cases manual compression

should be tried; and if pulmonary pressure falls and systemic pressure rises, then ligation may be done. With a lesser pulmonary-systemic ratio of flow ligation of the duct will result fatally because of lack of stimulus to higher resistance of the increased flow—in other words, intrinsic factors alone cause the high resistance.

Study of his cases and the pulmonary circulation in the fetus and early infancy led the author to a number of conclusions:

1. The very high pulmonary resistance in the fetus is caused largely by the tortuosity in the collapsed state of the lung.

2. The thick muscular arteries seen at this time represent the reaction to the high pressure.

3. Expansion of the lungs after birth unfolds the pulmonary vessels and rapidly lowers the pressure to systemic level.

4. Subsequent reduction of the pulmonary artery pressure is gradual, and depends on the relaxing effect of an increased alveolar oxygen tension on vasomotor tone, the inhibition of vasomotor tone that results from a fall in pressure *per se*, early closure of the ductus preventing an adverse hyperkinetic factor, and gradual involution of the muscular pulmonary arteries.

In Eisenmenger's syndrome with aortopulmonary or interventricular shunt, this favorable cycle is prevented by a powerful hyperkinetic factor which maintains the pulmonary artery pressure at systemic level. So long as pulmonary hypertension is maintained vasoconstrictor tone is not inhibited and the muscular pulmonary arteries do not involute.

[Reading of this paper in the original is highly recommended for the wealth of detail which could not be covered in an abstract.—Z. F. E.]

Twenty-four figures, including 10 roentgenograms; 6 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Cardiac Dextroposition: Hypoplasia of the Right Pulmonary Artery with Right Venous Pulmonary Drainage into the Inferior Vena Cava. M. Torner-Soler, I. Balaguer-Vintró, and J. Carrasco-Azemar. Am. Heart J. **56:** 425–430, September 1958. (Cardio-Angiology School of the University of Barcelona, Barcelona, Spain)

Because of angiocardiography, hypoplasia or absence of one of the main branches of the pulmonary artery is now being recognized as a definite clinical entity. This condition usually involves the right side and causes hyperfunction of the left lung and a hypoplastic right lung. This leads in the majority of cases to a pseudodextrocardia through a cardiac dextroposition. There may also be anomalous drainage of the right pulmonary veins into a venous collector which drains into the inferior vena cava.

A case is reported in which these two anomalies were associated. The patient was a twenty-two-year-old white female in whom dextrocardia was diagnosed at the age of ten years. She was asymptomatic. Chest films showed overdistention of the left lung with increased circulation on the left and displacement of the mediastinal contents to the right. At fluoroscopy a hilar dance was observed on the left with an apparent increase in size of the left hilar structures. On the right side no pulsations were visible, and the structures were quite small. An abnormal shadow was present at the right inferior cardiac border. It did not pulsate. Angiocardiography revealed hypoplasia of the right pulmonary artery with enlargement of the left pulmonary artery. Subsequently drainage from the right venous pulmonary shadow into the inferior vena cava was demonstrated.

Six figures, including 3 roentgenograms.

ROGER M. STOLL, M.D.
New York, N. Y.

The Angiocardiographic Features of a Patent Foramen Ovale. Louis A. Soloff and Jacob Zatuchni. Am. J. M. Sc. **236:** 434–437, October 1958. (Temple University School of Medicine and Hospital, Philadelphia, Penna.)

A case is presented illustrating the pathognomonic findings of a patent foramen ovale. The pathological physiology and differential diagnosis between patent foramen ovale and interatrial septal defect are discussed.

In the presence of an otherwise normal angiocardiographic circulation time, the pathognomonic finding is the demonstration of opacity in the left atrium from opacified right atrial blood, in the absence of mixing defects in the right atrium by nonopacified left atrial blood. The opacification of the left atrium is transitory because of subsequent dilution by nonopacified right atrial blood.

Flow through a patent foramen ovale is always from right to left and occurs only in association with an increased right atrial pressure. Flow from left to right never occurs. A chart depicting the duration of opacification of the great vessels and cardiac chambers is reproduced.

Four roentgenograms; 1 chart; 1 table.

W. J. VARLEY, M.D.
Mercy Hospital, Pittsburgh, Penna.

Aortic Stenosis in Infants and Children. Patrick A. Ongley, Alexander S. Nadas, Milton H. Paul, Abraham M. Rudolph, and George W. B. Starkey. Pediatrics **21:** 207–221, February 1958. (P. A. O., Chidren's Hospital, Boston 15, Mass.)

Isolated valvular aortic stenosis is comparatively uncommon in adults. In children it is often described as subaortic stenosis. During the past six years, the authors have seen 67 patients at the Children's Medical Center (Boston, Mass.), in whom a diagnosis of aortic stenosis was made. A complete history, physical examination, an electrocardiogram, fluoroscopy, and roentgenograms of the chest in the postero-anterior and oblique projections, were obtained on all patients. Combined catheterizations of the right and left sides of the heart were performed on 8 patients (twice in 1 of them). The diagnosis in all cases was based upon clinical criteria; confirmation was obtained by direct pressure measurements across the aortic valve in 8 patients and by necropsy in 2 additional cases.

All of the children in the authors' series were normally developed. All had a loud, rough, stenotic, systolic murmur at the second right interspace, as this was one of the criteria for diagnosis. In 63 of the 67 cases, a systolic thrill was present. Only one-fourth of the patients could be said to have normal electrocardiographic tracings, and these showed the expected left ventricular dominance for age. In the remaining patients the electrocardiogram showed left ventricular hypertrophy either on the basis of increased voltage alone or, in 15 cases with depression of the ST segment and inversion of the T wave, in the left chest leads.

Some patients were asymptomatic, although there were signs of severe left ventricular hypertrophy with depression of the ST segment and inversion of the T wave over the left chest leads. Of the 15 patients with signs of severe left ventricular hypertrophy, 4 died suddenly and, in 8 others who were subjected to left heart catheterization, the calculated area of the valve suggested severe stenosis.

There are no features in the roentgenogram which are constant in aortic stenosis in children. Since the resulting work load is borne principally by the left ventricle, one would anticipate the frequent roentgen finding of isolated left ventricular enlargement such as is encountered in essential hypertension or in coarctation of the aorta. Definite left ventricular enlargement was observed in 37 of the authors' patients. It was demonstrated both by an increase in the transverse diameter of the heart and by a downward sloping of the left ventricle. In some other patients the left ventricle in the left anterior oblique projection showed a rounded posterior curvature consistent with concentric hypertrophy. The ascending aorta was dilated in 26 cases, and in about half of these aortic pulsations were greater than normal. Hypoplasia of the aorta was not observed in any patient. Patients with severe disease and left ventricular failure may exhibit left atrial enlargement. In none of the cases in the present series was a calcified aortic valve detected and in all cases the pulmonary vasculature was normal, ruling out the possibility of significant left-to-right shunts.

Some patients with pure aortic stenosis may live a long and asymptomatic life; others may die suddenly at an early age following minimal exertion. It is important to know which patients will die in their teens and which ones will live a long life. From the authors' data it seems obvious that patients showing signs of left ventricular hypertrophy on the electrocardiogram and cardiomegaly by roentgenogram are more likely to encounter difficulty. Based on their small series, the outlook for patients with changes in the ST and T waves in the electrocardiogram is sufficiently bad that surgical correction of the lesions would be well worthwhile. Patients with progression of electrocardiographic evidence of left ventricular "strain" should be studied by catheterization of the left heart prior to deciding upon aortic valvotomy.

Nine figures, including 6 roentgenograms; 2 tables.

Radiology's Responsibility to the Atherosclerotic. Neil E. Crow and Byron G. Brogdon. J. Arkansas M. Soc. **55:** 151–154, September 1958. (Lackland Air Force Base, Texas)

Little has been said about the radiologist's opportunity, often fortuitous, to detect atherosclerosis in its earlier stages. He is trained to recognize arterial calcification, using this knowledge most often to differentiate arterial plaques from calculus, aneurysm, tumor, an inflammatory process, or physiologic calcification. Only occasionally, however, has arterial calcification been considered a valuable observation in itself.

Demonstration of calcific plaques in the arterial tree by the radiologist is as conclusive of the diagnosis of atherosclerosis as is biopsy. Although not apparent in the pathogenesis of the disease process, plaques are often seen as calcium deposits at the base of atheromata many years before the appearance of clinical symptoms.

As knowledge regarding clinical management of atherosclerosis increases, the radiologist's responsibility to identify subclinical cases becomes of greater importance.

Two roentgenograms.

The Role of Aortography in the Determination of Operability in Arteriosclerosis of the Lower Extremities. Edwin J. Wylie and Leon Goldman. Ann. Surg. **148:** 325–339, September 1958. (University of California School of Medicine, San Francisco, Calif.)

A review of the aortographic observations in 500 patients with arteriosclerotic obstruction involving arteries supplying the lower extremities forms the basis for this paper. The injection was made into the upper abdominal aorta in 290 cases and into the lower abdominal aorta in 210. The lower level is the preferred site for all studies except those in which there is clinical evidence of thrombosis of the abdominal aorta. The authors recommend placement of two 17-gauge needles to allow rapid simultaneous injection of the contrast material and obtain an adequate bolus for demonstration of arteries from the level of the injection to a point below the popliteal artery. Seventy per cent Urokon is the medium of choice, with the volume of injection ranging from 20 to 50 c.c. (usually around 40 c.c.). For each study four or five serial exposures were made on paired 14 × 17-inch films enclosed in special 36-inch cassettes. A tapered aluminum filter covering the tube aperture allowed more nearly equal penetration of the thicker abdomen and less dense extremities.

Serial film exposures are the only reliable method of obtaining an accurate visualization of the arterial tree distal to an occlusion. The variation in time of appearance of optimal opacity of the distal vessels precludes the use of single exposures. Specific information sought from the angiographic studies includes point of obstruction, location and degree of collateral circulation, length of the involved segment, status of the circulation distal to obstruction or occlusion, and *especially the condition of the intima of arteries in and adjacent to proposed operative sites.* The radiologic demonstration of irregularity of luminal contour has been found to be a reliable sign indicating intimal thickening and disease. This is an important factor in judging operability.

Clinically evident occlusive or stenotic lesions are divided into four groups: (1) those limited to the aorta-iliac area; (2) those limited to the femoral-popliteal segments; (3) lesions involving both aorta-iliac and femoral-popliteal segments; (4) lesions distal to the popliteal artery. The first three groups are considered potentially operable, and it is in these that evaluation of findings on a carefully performed aortogram is critical in determining operability.

Of 202 patients with clinical evidence of arterial obstruction in the aorta-iliac area 82 per cent were operable. Early intimal changes in distal segments were not considered to contraindicate surgery but in the presence of demonstrable gross arterial disease distal to the proximal obstructed segment operation was not considered feasible. In this group the procedure of choice appears to be thrombo-endarterectomy rather than a grafting procedure.

One hundred ninety-nine patients had lesions of the femoral-popliteal segments and in almost two-thirds of these additional lesions demonstrated by aortography were held to contraindicate operation at any level. The usual cause of inoperability was extension of intimal disease into the distal popliteal artery.

Patients with both high- and low-level lesions show a

lower operability rate, as is to be expected, but selected cases may be benefited.

Of all of the 500 patients studied in this series, 60 per cent were potentially operable, while 40 per cent were revealed by aortography to have multiple or diffuse lesions so that direct arterial operations were contraindicated. Extensive tables are presented to show the extent of disease, number of patients, site of operation, and adjudged operability of the patients in each of the clinical groups.

Aortography, in addition to the advantages outlined above, will usually demonstrate for the surgeon the best mode of approach and the length of segment to be dealt with.

A brief note on complications of aortography indicates a very low rate of adverse reactions for patients receiving injection in the lower abdominal aorta. In those receiving injections in the upper abdominal aorta the major difficulties arise with the kidneys, but even in the authors' extensive series of 290 such injections only one fatal reaction occurred (renal artery thrombosis). Many patients showed some temporary suppression of renal function but always with eventual recovery.

The points under discussion are exceptionally well illustrated by selected high quality angiograms. The article supplies a wealth of information for those interested in peripheral vascular surgery.

Thirty-three roentgenograms; 4 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Applicability of Angioplastic Procedures in Coronary Atherosclerosis: An Estimate Through Postmortem Injection Studies. D. Emerick Szilagyi, Richard T. McDonald, and Lloyd C. France. Ann. Surg. **148:** 447–459, September 1958. (The Henry Ford Hospital, Detroit, Mich.)

In a study of the feasibility of direct surgical technics in the correction of occlusive processes in coronary atherosclerosis, 190 human hearts, obtained at autopsy, were studied roentgenographically after the injection of the coronary arteries with a barium-glycerine mixture. Findings are divided into four main groups: normal, subclinical, clinical without angina, and clinical with angina. Seventy-six specimens, all from patients without clinical evidence of arteriosclerotic heart disease, showed no significant occlusive changes of important degree. In 35 cases there were demonstrable occlusive lesions but no clinical manifestation of coronary atherosclerosis. Cases with clinical atherosclerotic heart disease numbered 79, and in 23 of these angina pectoris was a prominent clinical manifestation. In general, films were obtained in two planes at right angles to each other, and zones of stenosis, occlusion, or atresia were marked and measured. Sharply localized, early occlusive lesions were generally limited to the subclinical group. As might be expected, the most advanced, widespread, multiple changes occurred in patients with clinical angina. It was noted that when coronary atherosclerosis is clinically manifest the findings in the heart tend to be generalized.

Judged by technical criteria which take into consideration the topographic accessibility, luminal size, and outflow characteristics of the main coronary branches, 43 per cent of the hearts in the subclinical group were judged inoperable; 17 per cent in the same group were regarded as capable of palliation, and 40 per cent as curable by direct surgical means. In the clinical group the theoretical rate of inoperability was 44 per cent, the rate of the possibility of palliation 43 per cent, and the curability rate 13 per cent.

The authors stress the need of a reliable clinical method of coronary angiography for visualization and evaluation of these lesions.

Selected roentgenograms and line drawings demonstrate very nicely the points under discussion. The pertinent data are presented in multiple-bar type graphs.

Seven roentgenograms; 8 line drawings; 6 graphs; 3 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Relationship of Systemic Venous Anomalies to the Paravertebral Veins. Herbert L. Abrams. Am. J. Roentgenol. **80:** 414–420, September 1958. (Stanford University School of Medicine, San Francisco 15, Calif.)

Angiocardiographic injections through the saphenous and femoral veins in 40 patients below the age of four showed significant opacification of the vertebral and azygos systems in two-thirds of the cases. These studies give support to Batson's concept of the vertebral venous system as a large, low-pressure intercommunicating reservoir of blood, in which alterations in pressure and direction of flow may occur.

In absence, hypoplasia or occlusion of the left innominate vein, the opaque medium injected through the left antecubital vein may flow into the left superior intercostal vein, thence into the accessory hemiazygos and the azygos veins, and finally into the superior vena cava. A portion of it may enter the paravertebral plexuses, cross the spine, and reach the superior vena cava through collateral channels.

If the inferior vena cava is occluded or absent, blood from the lower extremities may reach the heart through the paravertebral and azygos systems.

Occasionally, knowledge of these variations may have important practical implications. For example, ligation of the azygos vein in a case of absence of the hepatic portion of the inferior vena cava led to retroperitoneal hemorrhage and death.

Nine roentgenograms; 3 diagrams.

FREIDOUN ESKANDARI, M.D.
Cleveland Metropolitan General Hospital

Aneurysm of the Renal Artery. R. D. Sproul, Robert G. Fraser, and K. J. MacKinnon. J. Canad. A. Radiologists **9:** 45–48, September 1958. (Royal Victoria Hospital, Montreal, Quebec, Canada)

Renal aneurysms are said to account for about 1 per cent of all aneurysms. The prognosis is grave, and early diagnosis and prompt treatment are essential and sometimes life-saving. The clinical picture is nonspecific. Pain is the most commonly encountered symptom, and in order of frequency the signs include hematuria, a palpable mass, tenderness, hypertension, and a systolic bruit.

The diagnosis is largely radiological. The lesion will be demonstrable on plain films of the abdomen in 25 to 50 per cent of cases as a ring of calcium density with a deficiency in the ring where the aneurysm arises from the parent vessel. Pyelograms show a constant and close relationship to kidney. Aortography will allow positive identification. According to the authors, differentiation from other regional intra- and extrarenal lesions is not usually difficult.

Two cases are reported which were diagnosed preoperatively and successfully treated by nephrectomy.

Six roentgenograms.

CAPT. NEIL E. CROW, M.C.
Lackland AFB, Texas

Hypertension in Unilateral Renal Artery Stenosis with Arteriovenous Fistula; Arteriographic Demonstration in an 18-Year-Old Male. G. Gollmann. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 684–687, June 1958. (In German) (Zentral-Röntgen- und Radiuminstitut des Landeskrankenhauses Graz, Germany)

It has been shown in animal experiments (Goldblatt) that narrowing of a renal artery will produce hypertension and that removal of the ischemic kidney will restore the blood pressure to its normal level.

The author presents the case of an eighteen-year old youth with hypertension (200 mm. Hg) of undetermined origin. The routine intravenous pyelogram showed the right kidney to be smaller than the left, which raised the suspicion that it might be a "Goldblatt kidney." Aortography showed the right renal artery to be markedly narrowed near its origin from the aorta. After about 1 cm. of stenosis the vessel widened considerably and from the widened section a rather broad anomalous vein was seen to cross the spine into the left upper abdomen, passing downward into the pelvis to disappear near the left iliac artery. The simultaneous filling of the vessel with the aorta and the arteries suggested an arteriovenous fistula.

Following a right nephrectomy the blood pressure promptly returned to normal.

Five roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

A Contribution to the Technic of Aortography. H. Brasche. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 669–679, June 1958. (In German) (Chirurgische Klinik Ulm/Donau, Germany)

Three approaches are being used for the visualization of the aorta in the author's clinic: (1) the deep lumbar approach at the level of L-3 for the visualization of the abdominal aorta, the bifurcation, and the vessels of the legs; (2) the retrograde filling through the femoral artery for the visualization of the aorta above L-3; (3) the brachial artery approach for visualization of the thoracic aorta. This last is particularly advisable in isthmus stenosis of the aorta since the medium travels with the blood stream to fill the stenosed area.

For the deep lumbar approach the author uses the Denecke cannula, which has an opening below the tip along the side, so that the flow is not interrupted even if the tip becomes clogged. A mandrin is unnecessary. Through a small incision below the free edge of the 12th rib, the cannula is introduced and directed toward the body of L-3. When it strikes this landmark, it is withdrawn 1 or 2 cm. and its position is so changed that it will bypass the vertebra and enter the aorta. Before the introduction of the contrast substance, 1 per cent Novocaine (3 c.c.) is injected to prevent vascular spasm. Three series of exposures are made with a cassette changer: the first one after injection of 20 c.c. of 76 per cent Urografin to show the aorta and the iliac vessels; the second (again following 20 c.c.) to show the arteries of the thigh, and the third (again 20 c.c.) for the visualization of the lower leg.

The examination is made under barbiturate anesthesia. At its conclusion the needle is withdrawn very carefully to avoid ripping the wall of the aorta and for three to five minutes the musculature of the back is pressed against the aorta to prevent seepage of blood. Strict bed rest is observed for twenty-four hours.

Accidental puncture of the spinal canal is recognized by the return flow of fluid. Under these circumstances the needle is withdrawn and reinserted at a different angle. Filling of the renal vessels is not as dangerous as one might think because only 20 c.c. of the medium is injected at one time. Also, the previously injected Novocaine protects the vessels against spasm. Extravasation of the medium outside the aorta is recognized on the first film and the position of the cannula can be corrected. On one occasion the injection was made by accident into the vena cava, but no ill effects were observed.

For the visualization of the aorta above L-3 a polyethylene catheter with a mandrin is introduced into the femoral artery either percutaneously or after exposure of the artery. The position is fluoroscopically controlled. The mandrin is removed and a test film is taken after injection of 10 c.c. of the contrast substance. The position of the catheter may then be corrected if necessary. The pressure in the various sections of the aorta is recorded.

The author has never had any serious complications.

Thirteen roentgenograms; 3 drawings; 2 tables.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

A Slow Injection Method of Aorto-Arteriography. André J. Bruwer and F. Henry Ellis, Jr. Surg., Gynec. & Obst. **107:** 287–293, September 1958. (Mayo Clinic, Rochester, Minn.)

At least some of the dangers of translumbar aortography arise from injecting the contrast material directly into a vital artery or from flooding the renal arteries with too much material. Theoretically the procedure would be safer if it were accomplished by injection below the renal arteries, since the major abdominal branches arise above that level. This, however, is impractical because occlusive lesions frequently arise at or extend up to the renal arteries, and because the real object of the test may be to study the relationship of the major arteries to an aneurysm.

Within the framework of these conditions, the authors have devised a two-needle, two-site technic of injection which they believe to be simpler and safer than previous procedures. A preliminary puncture of the aorta is made at the level of the 12th thoracic vertebra. Twelve to 15 ml. of a 10 per cent solution of Urokon Sodium is injected in one to two seconds and a roentgenogram is taken at the end of the injection. This roentgenogram gives good information about the abdominal aorta and its visceral branches and determines where the second needle should be inserted in order to enter the abdominal aorta well below the main renal arteries. If the aorta is completely obstructed well above the bifurcation and the inferior mesenteric artery, the procedure is ended and, if further information is required, femoral aortography is done. In the absence of such obstruction, the second needle is inserted into the aorta at the site determined from the first roentgenogram. Ten milliliters of Urokon Sodium is injected and another roentgenogram obtained of the lower abdominal aorta and of the iliac and upper femoral arteries. If the second needle is well placed, the first needle is removed.

A 36 × 14-inch cassette containing 2 sheets of 14 × 17-inch film is now placed under the patient, extending down to the midcalves or ankles. With a 50-ml. syringe containing 40 to 45 ml. of Urokon and 10 to 15 ml. of saline, a slow continuous injection (10 to 15 seconds) is made. This results in simultaneous opacification of the arterial system down at least to the midcalf or even to the ankle.

The authors' experience with several hundred cases (number not stated) shows that the slow injection of slightly diluted opaque material, even in fairly large quantities, done below the level of the renal arteries, is capable of producing excellent arteriograms of the pelvis and legs with complete safety. The slow injection obviates the need for multiple exposures and cassettes since the whole system is simultaneously opacified at the time the exposure is made.

Ten roentgenograms.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Intravenous Angiocardiographies. An Analysis of 660 Cases. A. Castellanos, O. Garcia, and E. Gonzalez. Acta radiol. **50:** 261–272, September 1958. (University Medical School, Havana, Cuba)

The authors report their experience in performing 660 venous angiocardiograms, mostly on young children. A Fairchild camera with a field of 9.5 × 9.5 inches and a speed of two films per second was used. Seventy per cent Urokon and 70 per cent Diodrast were utilized in the majority of the cases, with a dose of 1.1 to 1.5 c.c./Kg. Six deaths were reported in this group, 5 in children under sixteen months of age with cyanotic congenital heart disease. It is the authors' contention that venous angiocardiography as opposed to cardiac catheterization is the safest and simplest method of studying congenital heart disease in pediatric patients. [With this conclusion the present reviewer would disagree. At Indiana University we have obtained over 450 selective cinecardioangiograms at the completion of cardiac catheterization. The mortality and morbidity figures are less than in the series reported here, and the information obtained was markedly better than could be obtained with venous angiocardiography at this slow filming rate.—E.C.K.]

Eight diagrams; 2 tables. E. C. KLATTE, M.D.
Indiana University Medical Center

The Sign of Early Regional Venous Opacification in Rapid Carotid Serial Angiography. E. Woringer, J. Baumgartner, and J. P. Braun. Acta radiol. **50:** 125–131, July-August 1958. (In French) (Hôpital Pasteur de Colmar, Haut-Rhin, France)

The procedure upon which this report is based consisted in carotid arteriography with one film per second for the first seven seconds and one film every two seconds for three more exposures. In none of 22 normal cases examined by this technic was early filling of the veins obtained. On the other hand, early venous filling was frequently demonstrated in malignant brain tumors and in vascular malformations, as well as in an occasional case of localized hyperemia in a circumscribed cerebral inflammatory process.

Four roentgenograms.

CHARLES M. NICE, JR. M.D., Ph.D.
Tulane University

Arteriography and Cardioangiography. S. B. Feinberg. Minnesota Med. **41:** 642–643; 663, September 1958. (University of Minnesota Hospitals, Minneapolis, Minn.)

The author presents 5 cases which demonstrate the value of arteriography or cardioangiography in determining the necessity and/or feasibility of surgery.

(1) Angiograms confirmed the impression of a massive arteriovenous communication of the right middle pulmonary lobe as well as a smaller one in the anterior segment of the right lower lobe in a 13-month-old Indian boy.

(2) A diminutive left pulmonary artery going to the left lower lobe with no branch to the left upper lobe was demonstrated in a 9-month-old girl in whom pulmonary agenesis had been suspected.

(3) In a woman of 28, catheterization studies indicated an interventricular septal defect with pulmonic stenosis. Surgical intervention, however, had led to an impression of aortic-pulmonic window. Selective angiography disproved the surgical impression and confirmed the catheterization findings. Incidentally delineation of the coronary arteries was obtained.

(4) In a 68-year-old man in whom percutaneous aortography was considered too dangerous, selective angiography with the aid of a catheter confirmed the presence of a fusiform aneurysm of the right external iliac artery.

(5) In a man of 60 with a carcinoid syndrome, ascites, and edema, the possibility of obstruction of the vena cava was disproved.

Seven roentgenograms.

Perforation of the Heart During Cardiac Catheterization and Selective Angiocardiography. Doris J. W. Escher, Jerome H. Shapiro, Berta M. Rubinstein, Elliott S. Hurwitt, and Sidney P. Schwartz. Circulation **18:** 418–422, September 1958. (Montefiore Hospital, New York, N. Y.)

The incident recorded here happened sometime during catheterization of the right heart in a case of mild pulmonary infundibular stenosis. No change in the patient's condition was noted at the time, but on viewing the films made after selective angiocardiography some of the contrast medium could be seen in the pericardial cavity. Close observation indicated the development of cardiac tamponade and the chest was opened, about two and a half hours after completion of the catheterization studies and an hour after angiocardiography. (Plain films at this time showed recognizable enlargement of the cardiac shadow.) A vertical pericardial incision was made anterior to the right phrenic nerve and blood-stained fluid, estimated at 200 ml., gushed forth under tremendous pressure. This had entered the pericardial cavity through a small perforation near the apex. The subsequent course was uneventful.

The physiological studies were done with a Cournand type catheter, which has a single opening at the tip. The catheter used for angiography was a National Institute of Health type, with a closed end and laterally placed holes to prevent recoil. It was thought that the perforation occurred when the second catheter (NIH) was advanced as the arm was raised just before injection.

Six roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Tilt Phlebography. Retrograde Phlebography by Ascending Injection. Kai Dohn. Acta radiol. **50:** 293-309, September 1958. (Ortopaedisk Hospital, Copenhagen, Denmark)

Most instances of incompetence of the valves of the deep leg veins follow a bout of thrombosis. The valvular defect remains, although recanalization may be almost complete. To determine the competence of the deep valves under the most trying physiological condition, namely, the abrupt assumption of the erect from a reclining posture, the author devised a system of phlebography to simulate just such stress.

The patient rests on a table capable of being tilted some 50° in two to three seconds, with the lower extremities 10 to 20° below the head to prevent the contrast agent from leaving the leg too quickly. The rapid tilt is essential to prevent the complete mixing of the medium with blood and its centripetal flow away from the field of interest. An ordinary x-ray tilt table is too slow for this purpose.

The leg to be studied is wrapped with an elastic bandage from the middle of the foot to the upper thigh to minimize filling of the superficial veins with the medium. The author prefers the elastic bandage to a proximal tourniquet since the former will reduce but not prevent filling of the superficial veins while the tourniquet alters the venous pressure and filling of both superficial and deep veins. The usual tourniquet above the ankle is used to direct the contrast material into the deep system. A cassette is then placed behind the thigh and a second behind the calf. The tube is fixed at a distance of 70 inches (175 cm.) and is centered at knee level for a frontal exposure. Forty milliliters of 35 to 60 per cent diodone is then injected into a dorsal vein of the foot in from thirty to forty seconds. Upon completion of the injection the patient is rapidly tilted to a nearly erect posture (a 60° foot-down position). The leg of interest is rotated inward and relaxed, while weight is borne chiefly on the opposite leg. Within five to ten seconds frontal exposures of the lower leg and the thigh are made. Lateral films are then taken with a second preset tube, if available. If not, the tilt table is rotated 90° and the tube adjusted for lateral projection. If the primary diagnostic problem is that of mapping incompetent perforators, a second frontal film should be exposed thirty to forty-five seconds after the change in position, provided the deep veins are normal. A final lateral film of the knee and thigh area is exposed immediately after muscular contractions caused by raising the heels twice. This will help empty the calf veins, especially in post-thrombotic legs. Pelvic phlebography with this method requires an independent exposure with an increase in the amount of injected medium and with prompt table tilting immediately after injection.

The advantage of the tilt method, as described, over retrograde phlebography in the recumbent or upright position lies in the failure of injection from above to outline the valves adequately. This is partly because of rapid forcing of the medium distally in the recumbent position and partly because of the great speed of travel downward in the upright position. With the retrograde technic, failure to disclose valves may be due to these technical deficiencies rather than to their congenital or pathological absence. Tilt phlebography, on the other hand, while requiring close attention to temporal and spatial details, gives a reliable demonstration of the valvular status as well as depicting incompetent communicating veins.

Thirteen roentgenograms; 2 photographs; 3 diagrams; 1 table. SAUL SCHEFF, M.D.
Boston, Mass.

THE BREAST

Roentgen Examination of the Breast. K. Werner, D. Buttenberg, and H. Zeitz. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 690–698, June 1958. (In German) (Czerny-Klinik der Universität Heidelberg, Germany)

In 27,517 examinations in an anti-cancer campaign, cancer of the genital organs was found in 0.8 per cent and cancer of the breast in 0.7 per cent, an almost equal incidence. However, while we have refined our diagnosis in cancer of the uterus by colposcopy and cytology (Papanicolaou test) we have no such diagnostic refinements in breast cancer. Therefore, improvements in radiological diagnosis assume great importance.

The authors' technic is based on the work of Leborgne, Gross, Gershon-Cohen. It calls for fine-grain film, without screens and a narrow cone 75 cm. long. The optimal tube current is 30 to 45 kv. Films are taken in craniocaudal and lateral direction. For the craniocaudal view the film is placed on a horizontal table, the breast rests on top of the film and, by means of the cone, the bottom of which is closed with a thin plastic plate, a mild compression is effected. For the lateral view the film is placed on a vertical stand and the tube with the cone, which is now held in a horizontal position, is used for compression in a similar manner. The roentgenograms, if inspected in a viewbox with variable light intensity, for the most part allow a satisfactory differentiation of the various shades of contrast between tumor and normal tissue, but the best differentiation can be obtained by artificial contrast intensification. Of the various apparatus obtainable, the most efficient one is the LogEtron.

The author presents two typical cases.

Eleven roentgenograms; 3 photographs.
WILLIAM A. MARSHALL, M.D.
Chicago 10, Ill.

THE DIGESTIVE SYSTEM

The Value of Cinematography in the Diagnosis of Malignant Strictures of the Oesophagus. F. R. Berridge and D. McC. Gregg. Brit. J. Radiol. **31:** 465–471, September 1958. (Addenbrooke's Hospital, Cambridge, England)

From time to time, every radiologist is faced with cases of lower esophageal stricture in which it is difficult, if not impossible, to determine by conventional barium swallow whether the lesion is benign or malignant. Benign conditions which are likely to be confused radiologically with malignant stricture are achalasia, stenosis due to peptic esophagitis, scleroderma, diffuse muscular hypertrophy, lower esophageal ring or web, and strictures due to swallowing corrosives. Diagnosis by esophagoscopy may also be difficult, and biopsy may need to be repeated several times before definite proof of malignancy is obtained.

During a two-year period, the authors examined by cinematography 7 cases which could not be classified following an orthodox barium swallow. The correct

diagnosis of a malignant lesion was made in 5 of them (with a sixth probably malignant, but unproved). Twelve patients with achalasia were also examined, 9 with peptic esophagitis, and 1 with corrosive stricture.

Views were obtained in both oblique positions with the patient standing as well as lying down. The camera was run at 8.3 frames per second, with Fluorodak film. The barium suspension was undiluted Micropaque.

The authors list the following criteria for establishing a diagnosis of esophageal cancer: (1) The wall of the esophagus is quite immobile where infiltrated by malignant neoplasm, while in peptic stenosis it retains the power of contracting normally, although it never expands to normal width. (2) Where the narrowing is very great, the barium appears to force the walls of a malignant stricture apart for a brief moment and the walls immediately come together again. In other forms of simple stricture the walls often appear to be apart when the barium enters the narrowed part, and, after the bolus has passed through it, the affected area contracts. (3) The bolus is always temporarily held up when it reaches a malignant stricture, but in cases of simple stricture due to peptic stenosis, the delay may be very short. (4) The mucosal pattern is obliterated in malignant strictures and esophagitis, but not in achalasia. (5) The esophagus adjacent to the lesions tends to move normally in malignant strictures and esophagitis, whereas in achalasia movement may be related to transmitted cardiac pulsations. (6) Malignant strictures do not straighten on full inspiration whereas simple strictures may do so. (7) Cardiac and aortic pulsations tend to move a malignant stricture backward and forward, whereas, with benign lesions, the heart tends to indent rather than displace the esophagus.

Brief histories of the authors' 5 malignant cases are included.

Thirty-four roentgenograms.

J. A. CAMPBELL, M.D.
Indiana University Medical Center

The Lower Oesophageal Ring or Groove. C. D. T. MacLean. Brit. J. Radiol. **31:** 472–476, September 1958. (Charing Cross Hospital, London, W. C. 2, England)

A ring or groove in the lower end of the esophagus may frequently be demonstrated about 3 cm. above the diaphragmatic hiatus when a large bolus of barium is swallowed by the patient in a prone position while the intra-abdominal pressure is raised by firm compression. The appearances are identical with the normal ampullary groove. Measurements taken from radiographs show the width of the groove to be 1 to 3 mm. and the depth of its projection within the esophageal lumen to vary between 1 and 20 mm. (average 5 mm.), though in half the cases it is only 2 to 3 mm. The groove is most obvious when the esophagus is distended fully, but its depth is not related to the degree of distention.

The author demonstrated this ring 76 times in the course of a few months in patients undergoing routine barium-meal examination. The average age for the series was forty-six; and the youngest patient was a girl of seventeen.

The author concludes that the ampullary groove is identical in appearance with the one they describe and can be demonstrated in a high proportion of patients. He states further: "the upward extension of the phreno-esophageal ligament is probably attached at this level and there may be a ring of muscle which acts as a sphincter. The groove separates the phrenic ampulla from the cardiac antrum. The cardiac antrum is the segment of the gullet within the normal oesophageal hiatus of the diaphragm and it is likely that raising the intra-abdominal pressure displaces it upwards to a level determined, in part at least, by the stretch of the elastic phreno-oesophageal ligament. The groove then appears at a point about 3 cm. above the hiatus. The term 'ampullary groove' in so far as it implies that the groove is on the phrenic ampulla, is probably incorrect.

"The establishment of a definite anatomical landmark at the lower end of the oesophagus may be of some value in showing the spatial relationship of the gastro-oesophageal segment to the diaphragm, and in this way may help in the diagnosis of some doubtful cases of hiatus hernia.

"It is tempting to assume that the symptomatic ring first described by Ingelfinger and Kramer (1953) is the groove between the phrenic ampulla and cardiac antrum, which is narrowed due to contraction of a sphincter, but a final conclusion must await further studies."

Eight roentgenograms; 2 diagrams.

R. E. MILLER, M.D.
Indiana University Medical Center

Esophageal Moniliasis: Report of a Case With Roentgenographic Findings. S. A. Kaufman and George Levene. Ann. Int. Med. **49:** 684–687, September 1958. (Massachusetts Memorial Hospitals, Boston 18, Mass.)

Infection with *Candida albicans*, a serious side-effect of intensive antibiotic therapy, has been recognized more frequently in recent years. Esophageal moniliasis is unusual, but presents radiographic findings distinctive enough to suggest the diagnosis in a patient in whom the disease may be unsuspected.

The authors describe a case in a 16-year-old white male, complaining of epigastric and substernal pain on swallowing. A gastrointestinal examination showed narrowing and irregularity of the lumen of the entire thoracic esophagus, loss of mucosal markings, and absence of peristalsis. The gastrointestinal symptoms were progressive and following a month of hospitalization, the patient died. During the last two weeks of life, a rapidly progressive leukopenia was noted.

At postmortem examination the final diagnosis of acute lympathic leukemia was confirmed. The esophagus showed thickening of the wall, due mostly to a thick coating of yellowish material. This produced a pseudomembrane which lined almost the entire lumen. Culture of this remarkable layer yielded *C. albicans*. Microscopic study of the esophagus revealed only a small segment of intact squamous epithelium. The greater part of the specimen showed ulceration and necrosis of the mucosa, which extended through the muscularis in many places. A thick mantle covered the ulcerated and necrotic portions. This consisted of a solid mass of budding cells, filaments, and necrotic debris.

One roentgenogram. STEPHEN N. TAGER, M.D.
Evansville, Ind.

Congenital Atresia of the Small Intestine: A Roentgenographic Study of 24 Cases. H. Gladnikoff. Acta radiol. Suppl. 164, 1958. (Sachska Barnsjukhuset, Stockholm, Sweden)

The author reports a series of 24 cases of congenital

atresia of the small bowel seen from 1939 to 1952. The incidence of this condition in the newborn has been variously reported as 1 in 20,000 to 1 in 5,000. It has been attributed to faulty recanalization of the bowel, the lumen of which is temporarily occluded in the 10- to 30-mm. stage of fetal development through proliferation of the originally simple epithelium. Duodenal atresia has been held to arise from congenital volvulus.

Atresia gives rise to ileus, which becomes acute when the newborn child swallows air and fluid. An early diagnosis is thus of vital importance.

The author's series includes 13 cases of duodenal atresia, 7 cases involving the jejunum, and 4 the ileum. There were 3 cases of multiple atresias but in the classification the one situated most orally has been considered. In 5 cases the atresia was incomplete, having the appearance of a fenestrated membrane or a very narrow bowel segment with a fine lumen. In 3 instances the colon lay to the left of the midline. Thus in malrotation of the colon with ileus, atresia of the small bowel must be considered, as well as volvulus.

For the roentgen diagnosis in his cases the author made use of plain films and the barium meal and barium enema. Since barium meal studies added little to the information otherwise obtained and were time-consuming, they are considered unnecessary. For the barium enema examination the barium mixture is introduced through a soft catheter with the child's buttocks compressed around it manually or by strips of adhesive. The method of inflating a balloon around the catheter is condemned.

Poststenotic narrowing of the colon and rectum is a significant feature. The mean value of the colon diameter in normal infants is 23 mm. with limits of 16 and 30 mm. In cases with complete occlusion of the small intestine, the mean average diameter is 9 mm. with limits of 5 and 14 mm. In 2 cases with partial occlusion of the small intestine the colon diameters measured 13 mm. and 18 mm. respectively. A similar relationship was found in the rectum. An abnormally narrow colon indicates among other things that the child has ileus which is of congenital origin. This may be seen in meconium ileus and in cases of malrotation associated with volvulus, as well as in other forms of prenatal congenital obstruction of the bowel.

Forty-four roentgenograms; 3 graphs; 1 table.

MARTIN A. PLATSKO, M.D.
The Henry Ford Hospital

Inflammatory Pseudopolyposis of the Small and Large Intestines with the Peutz-Jeghers Syndrome in a Case of Diffuse Histoplasmosis. Solomon R. Bersack, John S. Howe, and Alan S. Rabson. Am. J. Roentgenol. **80:** 73–78, July 1958. (2650 Wisconsin Ave., N. W., Washington 7, D. C.)

The Peutz-Jeghers syndrome consists of circumoral labial, intraoral mucosal, and digital pigmented melanotic spots associated with polyps of the small intestine. The concomitant features are episodes of obstruction, intussusception, rectal bleeding, and a tendency toward malignant degeneration. There is a familial history of the syndrome in 70 per cent of cases.

A case is reported here which clinically resembled the Peutz-Jeghers syndrome, but in which the intestinal lesions were proved to be nonadenomatous, inflammatory pseudopolyps due to disseminated histoplasmosis. Histoplasmic lesions were also present in the adrenal glands, where diffuse tissue destruction had been produced. It seems possible that this case represents one in which histoplasmosis produced inflammatory pseudopolypsis of the small and large intestine as well as destructive changes in the adrenal glands. This, in turn, leads to terminal Addison's disease and to pigmentation which is similar to that seen in the true Peutz-Jeghers syndrome.

Five roentgenograms; 3 photomicrographs; 4 photographs.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

Leiomyoma of the Duodenum. W. N. Coombes. Brit. J. Surg. **46:** 127–129, September 1958. (Hospital Rockcliffe, Ottawa, Ont., Canada)

Five per cent of reported smooth-muscle tumors of the gastrointestinal tract are leiomyomas of the duodenum. These tumors ordinarily are found in the first and second parts of the duodenum. A leiomyoma arising in the third part and diagnosed correctly by radiographic methods is reported here.

A 43-year-old male complained of dull pain in the right lower abdomen, mild frequency of micturition, and malaise, of a few days duration. Radiologic examination of the upper gastrointestinal tract showed a smooth, tongue-like filling defect in the lumen of the third part of the duodenum without intestinal obstruction. Excretory pyelography showed lateral displacement of the upper right ureter at the level of L-2 and 3, with a normal lower course and no obstruction. At operation a well demarcated tumor was found in the third part of the duodenum, presenting as a mass in the retroperitoneal space medial to the ascending colon and below the transverse mesocolon. The tumor was firmly adherent to the right ureter and had displaced it. Right colic vessels passed through the lesion. Segmental resection of the duodenum and appropriate end-to-side anastomosis with the jejunum were done. Follow-up examination fourteen months after surgery showed no evidence of recurrence.

Histologically it was not easy to determine whether the tumor was benign or malignant and early impressions favored the latter. However, the course and further review of the tissues led to a final diagnosis of a benign lesion, a leiomyoma.

One roentgenogram; 2 photomicrographs.

JAMES W. BARBER, M. D.
Cheyenne, Wyo.

Primary Carcinoma of the Jejunum. Chester Cassel and Harold M. Unger. Am. J. Digest Dis. **3:** 669–681, September 1958. (School of Medicine, University of Miami, Miami, Fla.)

The authors report 7 cases of jejunal carcinoma seen over a period of four years. The lesions develop insidiously, the most frequent symptom being indefinite pain due to obstruction or invasion of the parietal peritoneum. Other complaints, encountered less frequently, are a sense of fullness or bloating and gradually increasing constipation. Progressive vomiting may be the presenting feature. When the vomitus contains bile, the obstruction is beyond the ampulla. The semiliquid consistency of the stream allows the lesion to produce almost complete stenosis before obstruction supervenes. Melena is rare, although anemia may appear with chronic blood loss. Weight loss is a constant finding. In only one of the 7 cases observed was a mass felt.

The x-ray findings depend largely on the stage of the

tumor at the time of study. When obstruction has occurred, upright abdominal films will reveal fluid levels in distended loops of small intestine with gastric dilatation in some cases. In the absence of gross obstruction, the barium meal study will show dilatation of the stomach, duodenum, and jejunum as far as the area of narrowing. At the site of the lesion there may be mucosal distortion, a filling defect, or conical obstruction with a shelf. In cases of suspected obstruction the barium may be introduced through a tube to the region of the lesion and then aspirated. The small bowel should be suspect in all cases in which routine studies of the upper and lower tract are fruitless.

Pathologically the lesions in the jejunum are more commonly carcinomas. Treatment is resection with an attempt at cure. The survival rate is poor, 20 to 25 per cent at five years. A better prognosis awaits earlier diagnosis based on a higher index of suspicion.

Four roentgenograms; 1 photomicrograph; 1 photograph; 2 tables.

SAUL SCHEFF, M.D.
Boston, Mass.

Regional Enteritis. I. Clinical Aspects and Diagnosis in 100 Patients. John E. Daffner and Charles H. Brown. Ann. Int. Med. **49:** 580–594, September 1958. (C. H. B., Cleveland Clinic, Cleveland 6, Ohio)

Regional ileitis is defined as a recurrent granulomatous disease mainly affecting young adults. In the acute inflammatory phase, ulcerative lesions are prominent; later, thickening of the mucosa, scarring, intestinal obstruction, and fistulas may be present. The terminal ileum is chiefly involved, although lesions may occur elsewhere in the small intestine or may cross the ileocecal valve to involve the colon (ileocolitis). The disease is characterized clinically by abdominal cramps, signs of obstruction, diarrhea, fever, loss of weight, and anemia, and by the presence of an abdominal mass, perianal abscesses and fistulas. The etiology remains obscure.

The authors review the findings in 100 patients who were seen from 1946 through 1956. The varied symptoms and statistical data are thoroughly evaluated and reported in detail.

If the terminal ileum is visualized on a barium-enema study, the findings on this examination frequently can be the basis for the diagnosis. The loss of the normal mucosal pattern in the terminal ileum is suggestive, and the narrowed "string" sign in more chronic cases is diagnostic. In the present series the barium-enema examination alone was diagnostic in 28 per cent. In 11 per cent of the patients in whom a barium-enema examination was not done, small bowel motility studies were positive. Results of motility studies were diagnostic and findings on barium-enema examination were negative in 4 per cent. Results of motility studies were negative and findings on barium-enema examination were positive in 2 per cent. Consequently, findings on barium-enema examination were diagnostic in 85 per cent and falsely normal in 4 per cent of the 100 patients.

The predominant roentgen findings were: narrowing and mucosal changes (31 patients); mucosal changes alone (23); narrowing with some dilatation proximally (20); and definite obstruction (10). Fistulous tracts were demonstrated in only 10 patients, although a total of 27 had internal or external fistulas, or both. Filling defects were noted in 6 patients.

Small-intestinal motility studies are indicated in those patients in whom there are suspicious clinical findings and in those in whom the terminal ileum appears to be abnormal on barium enema study.

Four roentgenograms; 6 tables.

STEPHEN N. TAGER, M.D.
Evansvillle, Ind.

Modern Trends in Diagnostic Roentgenology of the Colon. The Mackenzie Davidson Memorial Lecture. Sölve Welin. Brit. J. Radiol. **31:** 453–464, September 1958. (Malmö Allmänna Sjukhus, Malmö, Sweden)

During the last few years increasing demands have resulted in serious attempts by radiologists to improve and refine the barium-enema technic. Use of a semi-transparent medium, over-exposed films, high-voltage roentgenography, and addition of tannic acid to the medium have been tried. The author believes, however, that double contrast, first introduced in 1923 by the German investigator Fischer, is superior to them all. There is now general agreement that the double-contrast method implies a clear improvement for the demonstration of small tumors but it has not been widely accepted for routine use.

Four conditions must be satisfied if this technic is to be used routinely. First, a method capable of getting the intestine as clean as possible is required. Second, the intestinal mucosa should be prepared in such a way as to permit the adhesion of an extremely thin and even contrast coating on the intestinal walls. Third, it should be possible to regulate evacuation so that the various steps of the examination can be carried out at very short intervals, with avoidance of any unnecessary waiting time. Finally, it should not be necessary for the patient to be in the x-ray room more than twenty to twenty-five minutes.

Cleansing of the bowel presents a serious problem. The author tried certain preparations such as isatin (Exakton) and tannic acid, and finally used a mixture of these (Clysodrast Novum). He also gives 1 mg. atropine by mouth thirty minutes before the examination to reduce mucus secretion and the pain of intestinal contractions; 15 c.c. of castor oil is given the day preceding the examination.

Ten examinations are done per morning in one x-ray room with five adjacent toilets, 6 dressing cubicles, and one cleansing room. The patient travels from dressing room to cleansing room for the cleansing enema, and thence to the toilet. He then receives his first contrast enema (a barium-Clysodrast mixture, specific gravity 6.5), which should reach only as far as the splenic flexure. A lateral view of the filled rectum is taken and the patient is again sent to the toilet. He returns for the second contrast enema, which reaches to the middle of the sigmoid colon. Air is then introduced, in the prone position; the patient is rotated 360°, and the contrast medium drained off with an ordinary enema pipe. Multiple films are taken with both vertical and horizontal beams. Film-focus distance is 1.5 meters.

After some 9,000 examinations by this method the author believes that it will reveal mild forms of ulcerative colitis, which may be missed by conventional procedures. He feels also that the rectum can be examined as well as or better than by proctoscopy. In cases of known colitis he does not use Clysodrast except occasionally in the cleansing enema.

The greatest value of this method is that it permits an early diagnosis of cancer. Eleven per cent of the

patients examined showed polypoid tumor or "polypoid new formation" and almost half of those operated upon had cancerous or precancerous changes.

Treatment of polypoid tumors in children may be somewhat expectant, since spontaneous regression has been observed. Six months and twelve-month check films are made of "polyps" that remain stable. Those that grow should be operated upon. All polyps reached by the proctoscope are removed without delay.

Indentation of the intestinal wall around the base of the tumor is considered a sign of malignancy and for this reason an attempt is always made to get profile views. The absence of such indentation, however, does not exclude malignancy. This sign is regarded as a definite indication for operation.

The only complication noted in all the examinations was the presence in one case of retroperitoneal air at proctoscopy, and at operation later. No explanation could be found.

The author feels that the removal of benign polyps is prophylaxis against cancer, and that routine air contrast study is the examination of choice.

Thirty-two roentgenograms; 1 diagram; 3 tables.

R. E. MILLER, M.D.
Indiana University Medical Center

Congenital Cystic Dilatation of the Common Duct. Carlos Payet G. Acad. peruana de cir. **11:** 234–250, September 1958. (In Spanish)

The extreme rarity of so-called congenital cysts or idiopathic cystic dilatations of the common duct warrants publication of case records. Judd and Green of the Mayo Clinic in 1928 demonstrated the infrequency of this lesion, finding only one case in 17,381 operations on the biliary passages during twenty years. The Presbyterian Hospital in New York in 1942 reported only 2 cases among 757,000 operations in the history of that institution. Cantey in 1956 was able to accumulate a total of 217 described cases. These lesions are characterized by tumor in the right upper abdominal quadrant, not appreciably movable on respiration, firm or occasionally fluctuating in size; there may be an apparent connection with the hepatic border. Icterus occurs in 70 per cent of the patients; 65 per cent complain of vague, inconstant pain which is sometimes of a colicky nature and does not radiate.

The author reports the case of a five-year old child, whose abdomen was enormously distended, pushing the heart, liver, and other subphrenic organs high up into the thorax. The cyst was marsupialized prior to resection. The child made an excellent recovery and progressed normally. Postoperative x-ray examination showed the liver, spleen, stomach, and the other organs in normal position. JAMES T. CASE, M.D.
Santa Barbara, Calif.

Gas in the Pancreas as a Sign of Abscess. John W. Agnos and R. Brian Holmes. Am. J. Roentgenol. **80:** 60–66, July 1958. (University of Toronto, Faculty of Medicine, Toronto, Ont., Canada)

Abscesses of the pancreas may occur in association with acute pancreatitis or may follow an exacerbation of chronic pancreatitis. Persistence of symptoms and a constantly elevated serum amylase usually indicate abscess development. Gas in a pancreatic abscess is rare. When it does occur, it may arise *via* communication with a neighboring hollow viscus or it may come from gas-forming organisms within the abscess.

Spread of the abscess is most commonly into the lesser peritoneal sac and anterior to the pancreas. Gas in such a location shows on the roentgenogram as a long air-fluid level. When the gas is confined to the limits of the pancreas or to a space such as the retroperitoneal tissues, the mixture of gas and necrotic tissue produces a mottled appearance on the x-ray film. Initially the gas is present as small, radiolucent bubbles which, with progression of the disease, enlarge and coalesce until single or multiple fluid levels are formed. Sometimes the shaggy outline of the roof of the abscess is visible. Demonstration of multiple small radiolucent gas bubbles in or near the region of the pancreas is not pathognomonic of pancreatic abscess, but such findings are to be evaluated in the light of signs of subphrenic abscess and of elevated serum amylase. In such circumstances the diagnosis of pancreatic abscess should be strongly entertained.

Two cases of gas-containing pancreatic abscesses are added to those appearing in the literature.

Eight roentgenograms.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

Acute Pancreatitis with Peritoneal Fat Necrosis—Roentgen Diagnosis. Thomas B. Merner. Am. J. Roentgenol. **80:** 67–72, July 1958. (1412 E. 24th St., Minneapolis 4, Minn.)

Two cases are reported in which roentgenograms showed multiple, nodular, mottled areas of increased density in the abdomen representing areas of fat necrosis. In the presence of severe pancreatitis, pancreatic enzymes are released into the peritoneal cavity, where they transform the fatty tissues into calcium soaps by combination with the calcium from the blood serum. The nodular shadows on the roentgenograms are produced by these calcium soaps in necrotic areas in contrast with the more normal areas of unaltered lipoid material. The finding of fat necrosis assists in the diagnosis of acute necrotic pancreatitis and indicates a very serious prognosis. The disease may be quite acute, with zones of fat necrosis demonstrable within forty-eight hours after onset.

Seven roentgenograms.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

THE MUSCULOSKELETAL SYSTEM

Chondrodystrophia Calcificans Congenita. Byron G. Brogdon and Neil E. Crow. Am. J. Roentgenol. **80:** 443–448, September 1958. (Lackland Air Force Base, Texas)

Chondrodystrophia calcificans congenita is a rare disorder of infancy characterized by multiple discrete punctate areas of calcification in the epiphyses of the hip, knees, shoulders, wrist, and less commonly the vertebrae, pelvis, and rib ends. Associated changes are shortening, thickening, and bowing of the shafts of the long bones, with cupping, widening, and irregularity of the metaphyseal ends. Flexion deformities, clubfoot, congenital dislocation of the hips, monomelic shortening, saddle nose, microcephaly, oxycephaly, dwarfism, mental deficiency, cleft palate, cardiac defect, cataract, and poor resistance to infection may be present as associated abnormalities.

Anatomically there is disturbance of vascularization of the epiphyseal cartilage. There is evidence that the

disease has a familial distribution and shows simple recessive mendelian inheritance. In each of the 2 cases reported by the authors there was the characteristic stippling of the epiphyses plus a number of the aforementioned abnormalities.

In the differential diagnosis cretinoid epiphyseal dysgenesis, the osteochondrodystrophies, dysplasia epiphysialis multiplex, chondrodystrophia foetalis, ectodermal dysplasia, and congenital syphilis are to be considered.

Ten roentgenograms; 1 photograph.

FREIDOUN ESKANDARI, M.D.
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Chondroectodermal Dysplasia (Ellis-van Creveld Syndrome). Report of Two Cases. Harris L. Smith and Albert M. Hand. Pediatrics **21:** 298–307, February 1958. (H. L. S., Frank T. Tobey Memorial Children's Hospital, Memphis 3, Tenn.)

In 1940, Ellis and van Creveld described the syndrome comprised of ectodermal dysplasia, chondrodysplasia, polydactyly, and congenital heart defect, and reported 3 cases. Since that time 6 additional cases have been recorded. The authors add 2 more, 1 in a Negro; both cases exhibited all four of the principal features of the syndrome.

No serious difficulty has arisen in the differential diagnosis in any of the cases recorded in the literature. It is conceivable, however, that in patients who are lacking one or more of the typical components of the syndrome there might be some confusion with conditions such as chondrodystrophy, calcareous chondrodystrophy, Morquio's disease, osteopetrosis, osteogenesis imperfecta, and other forms of micromelia. In most of these conditions the diagnosis can be arrived at from physical examination and roentgen studies. Ectodermal defects are not considered characteristic of any of the above disorders.

In the differentiation of this entire group of conditions one must rely heavily on the roentgen changes. Caffey (Am. J. Roentgenol. **68:** 875, 1952. Abst. in Radiology **61:** 687, 1953) has stressed the pathognomonic pattern seen in cases of chondroectodermal dysplasia, *e.g.*, progressively increased shortening from the trunk to the distal phalanges. The root bones of the extremities are relatively the longest in contrast to classical achondroplasia in which the converse is true. The proximal ends of the ulnae and the distal ends of the radii appear too small. In one of the earlier cases and in one of the authors' patients the discrepancy in length between radii and ulnae led to compensatory dislocation of the radial heads. In every case thus far observed there has been a secondary characteristic feature—the widened ends of the tibial shafts appear irregular and the ossification centers in the proximal epiphyseal cartilages are hypoplastic. There is a tendency toward fusion of metacarpals and fusion of capitate and hamate bone. Polydactylism in the feet is the exception rather than the rule. Pelvic deformity was found in one adult patient with chondroectodermal dysplasia undiagnosed in childhood. Abnormal formations of cartilage may occur and interfere with the function of multiple joints. Such cartilaginous formations were a prominent feature in one of the authors' cases, in which the acetabular fossae and elbow joints were markedly involved.

Three roentgenograms; 3 photographs; 2 photomicrographs.

Osteoporosis of Unknown Cause in Younger People: Idiopathic Osteoporosis. W. P. U. Jackson. J. Bone & Joint Surg. **40-B:** 420–441, August 1958. (Groote Schuur Hospital, Cape Town, Union of South Africa)

Despite the many known and theoretical explanations for osteoporosis, there remains a group of cases in which the cause is entirely unknown. Affected people are usually young and seem to exhibit no common etiological denominator.

The author stresses that he does not have any good theory concerning the etiology or any particular form of therapy to offer. However, he presents an analysis of 38 cases of what has been generally considered to be a rare condition. Illustrative case histories are included. The peculiarities of the disease as it is seen in women are discussed, particularly the relationship to pregnancy and lactation, which appear to act as precipitating factors.

The spine is predominantly involved. Radiologically there are ballooning of the disks into the vertebrae, producing biconcavity of the bodies, more localized disk herniations (Schmorl's nodes), small breaches in continuity of the vertebral plates, anterior wedging, and compression of varying degree of the whole vertebra. After wedging or compression has been present for a long time, osteophytic outgrowths occur from the vertebral bodies in the region of the cartilaginous plates, often from contiguous vertebrae.

Differential diagnosis and possible etiological factors are discussed. The only conclusion regarding etiology is that some people are more prone to bone loss than others, and in the former a variety of accentuating factors may render the disorder clinically apparent.

Fourteen figures, including 8 roentgenograms; 1 table.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Rare Causes of Enlargement of the Spinal Canal. G. Lombardi and G. Morello. Acta radiol. **50:** 230–234, July-August 1958. (In French) (Institut Neurologique, Milan, Italy)

It is postulated that any persistent pathologic process which produces continuous localized pressure may cause changes in the vertebral column, and conventional roentgenography and even myelography do not generally provide an accurate preoperative diagnosis. Seven cases are reported: a chordoma of the cervical region, myelomatous infiltration in the thoracic region, lipoma of the distal end of the spinal cord, dermoid tumor, a large herniated disk, extradural arachnoid cyst, and aneurysmal dilatation of the subdural arteries at the level of L 1–2. The widening of the spinal canal and erosion of the pedicles were seen on plain films and various forms of block were apparent on the myelograms. In 6 of the 7 cases, however, the definite nature of the lesion awaited surgery.

Eight roentgenograms.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

Vertebra Plana. A. T. Fripp. J. Bone & Joint Surg. **40-B:** 378–384, August 1958. (Royal National Orthopaedic Hospital, London, England)

Since 1925, when Calvé first described the condition that bears his name, many additional cases have been recorded, usually with the emphasis upon immediate radiological appearance, diagnosis, or treatment.

In 1954, Compere, Johnson, and Coventry reported 4 such cases in which biopsy revealed eosinophilic granuloma (J. Bone & Joint Surg. **36-A:** 969, 1954. Abst. in Radiology **65:** 307, 1955). In their patients, treatment consisted either of deep x-ray therapy or a combination of deep x-ray therapy and bone grafting. There was, however, no long-term follow-up among these patients.

Four cases of vertebra plana are reported in the present paper, all followed for a considerable period. The patients were three, seven, eight and twelve years of age when first seen. There was a history of trauma in the 3 younger children. Original radiographs of each child show marked collapse of the vertebral body with normal adjacent vertebrae.

Follow-up films twenty-two years after onset in 3 patients and twelve years after onset in the twelve-year old boy all showed virtually complete regeneration of the affected vertebra. In 3 of the patients a narrow line of sclerosis (the ghost vertebra) representing the original collapsed vertebral body was apparent in both the anteroposterior and lateral projections.

All 4 patients were treated by a period of recumbency. There was no x-ray therapy. No biopsy was performed.

The author suggests that in solitary vertebra plana radiotherapy may not be necessary and that irradiation should probably be limited to those patients with evidence of multiple lesions.

Seventeen roentgenograms.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Flexion of the Lumbar Spine as an Aid in the Localization of Intervertebral Disk Herniation. W. Rübe. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 656–662, June 1958. (In German) (Strahleninstitut der Freien Universität Berlin am Stadt. Krankenhaus Westend, Germany)

According to the author's experience, most cases of disk prolapse occur between L-4 and L-5 (88 per cent), and he has been able to make the diagnosis and localize the prolapse in 40 per cent of the cases by plain films.

The straight anteroposterior view may give a clue. In patients in whom this view shows a "depression" (*Einsenkung*) of L-5 between the iliac bones or sacralization of L-5 disk, prolapse may be suspected. The author speaks of "depression" if a line drawn across the superior iliac crest strikes the fourth lumbar vertebra above the midline. Thirty per cent of his proved cases of disk herniation showed this sign.

Of more diagnostic value is the anteroposterior view taken with the spine flexed toward the right or toward the left. While the normal disk spaces will assume a wedge-shaped appearance in lateral flexion, the pathological disk space, as a result of local muscular spasm, will retain the same appearance that it had in the erect position, and this area will not take part in the flexion. Cases of scoliosis are excepted from these observations, since the disk spaces in this condition may normally appear to be wedge-shaped.

Of greatest importance are the lateral views. In the erect lateral view the pathological disk space will often appear wedge-shaped, the narrow part of the wedge being seen anteriorly. This sign is exaggerated in lateral views in extreme ventral flexion and dorsal extension. In ventral flexion the outspoken wedge-shaped appearance with disk herniation and anterior collapse of the disk is especially apparent in comparison with the slight harmonious wedging of the normal disks. In dorsal extension also the pathological disk space fails to fit into the pattern of the others.

Fourteen roentgenograms: 2 diagrams.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Perineural Cysts of the Lumbar and Sacral Nerve Roots. O. Wiedenmann. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 662–669, June 1958. (In German) (Nervenklinik der Universität München, Germany)

Perineural cysts of the lumbar and sacral nerve roots occur in the extradural section of the nerve roots and of the filum terminale. They are mostly found in the posterior nerve roots and may reach up to the spinal ganglion, often including it. They may be single or multiple, microscopically small or several centimeters in diameter.

On the plain film a localized dilatation of the sacral canal or of the sacral foramina can sometimes be seen. Most cysts, however, can be demonstrated only by means of a myelogram. As the communication between the cysts and the subarachnoid space may be very narrow, it may take hours or days before the cysts can be visualized.

In the author's series of 48 myelographies, cysts were discovered in 5 cases and in all were incidental findings, as the myelography had been done to investigate disease in the cervical area. Statistics in the literature show that these cysts occur quite frequently. Most of them do not produce any clinical symptoms. If, therefore, they are discovered in the presence of clinical findings, the examination should not be terminated until all other possibilities have been eliminated as a cause of the complaints.

For the best visualization of the cysts the author recommends that radiopaque material be left in the spine and the films be taken on the following day, after the patient has been walking around to facilitate the distribution of the contrast agent along the fine channels.

It is believed that most of these cysts are due to a congenital anomaly.

Eight roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Postoperative Bone Changes Following Lumbar Disc Removal. E. C. Schultz. J. Neurosurg. **15:** 537–547, September 1958. (Department of Neurosurgery, University of Tennessee College of Medicine, Memphis, Tenn.)

In a series of more than 4,000 operations for protruded lumbar disks 5 cases were encountered in which there were painful postoperative complications of such severity as to require prolonged therapy and weeks in bed. These 5 cases, and 1 additional case from another institution, are reported in detail. Severe pain requiring treatment had its onset between the fifth day and the fifth month after surgery. It was made worse by movement. Muscle spasm was present. In 3 cases, marked abdominal pain suggested the possibility of intra-abdominal disease.

That this complication may be inflammatory disease in the disk space has been recognized. The roentgenographic changes suggested that the pathologic

process was a septic one. However, the patient did not present the clinical picture of an acute inflammatory process and on re-operation in 2 cases no evidence of infection was noted. Bacteriologic studies were negative. Surgical trauma space seemed unlikely as a cause, as in 1 case the affected disk space had not been entered surgically.

Roentgenograms made shortly after the onset of severe postoperative pain demonstrated a narrow disk space with absorption and sclerosis of the adjoining portions of the vertebral bodies. In one instance minimal involvement was evident only on laminagrams. Follow-up roentgenograms usually showed further narrowing of the involved interspace, with bony fusion of the two adjoining vertebral bodies. In 1 case, a roentgenogram four years after operation revealed complete bony restitution and a normal interspace.

Believing that the lesions might be a type of aseptic necrosis or "osteochondritis," the author tried roentgen therapy in the hope of obtaining relief of pain as sometimes results in similar conditions (osteitis pubis, osteitis of tibial tubercle). Total dosage was 800 to 1,500 r given in divided doses, usually 200 r per treatment. All patients experienced relief after irradiation, with time and rest.

In an addendum, 2 additional cases are recorded. The author believes that many less severe cases have probably been overlooked and that such patients may be neglected or misjudged.

Fifteen roentgenograms.

EUGENE A. CORNELIUS, M.D.
Houston, Texas

The Iliac Apophysis and the Evolution of Curves in Scoliosis. Alexander L. Zaoussis and J. I. P. James. J. Bone & Joint Surg. **40-B:** 442–453, August 1958. (J. I. P. J., Royal Northern Orthopaedic Hospital, London, England)

The observation has been made by Risser and confirmed by several others that "the completion of ossification excursion of the iliac apophysis has proven to occur simultaneously with the completion of vertebral growth, and with it the curvature is static." This has practical importance for the surgeon managing scoliosis, who needs to know for certain if curve progression is static.

The authors present statistical evidence to support this view. They review 224 cases, reaching the following conclusions:

1. Spinal growth and curve progression coincide with the completion of growth in the iliac apophyses; this also applies to paralytic curves.

2. In a high number of cases this ossification center showed an asymmetrical development on the two sides of the pelvis. The appearance of a separate posterior center of ossification is also common, and probably represents an advanced stage in the growth of the iliac apophysis.

3. Menarche and the growth of the apophyses of the vertebral bodies almost always occurred in advance of the iliac apophyses. They should be regarded as early signs of maturation, not reliable in the prognosis of curve progression.

4. The growth of the iliac apophysis appeared to be unaffected by poliomyelitis.

Fourteen figures, including 10 roentgenograms; 4 tables.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Achondroplasia of Pelvis and Lumbosacral Spine: Some Roentgenographic Features. John Caffey. Am. J. Roentgenol. **80:** 449–457, September 1958. (Babies Hospital, New York, N. Y.)

In achondroplasia the basic defect is slowed cartilaginous growth and irregular enchondral ossification in all bones of cartilage origin. The characteristic abnormalities in the bones of the extremities are well known. This article discusses changes in the pelvis and lumbosacral spine, which at times may furnish a clue to radiographic differentiation from late rickets, metaphyseal dysostosis, Morquio-Brailsford disease, gargoylism, and dyschondroplasia.

In the pelvis the ilia are the most conspicuously affected bones. They are small and tend to be square. Most of the ilium below the postero-inferior spine is underdeveloped or missing. The acetabular angles are quite small. The sacrum is small and articulates low on the ilia. The lumbosacral angle is very acute.

In the spine the intervertebral spaces may be as wide as the adjacent vertebral bodies. There is undergrowth of the pedicles, with consequent flattening of the ventrodorsal dimensions of the spinal canal. The interpediculate distance decreases from L-1 to L-5 instead of showing the normal increase. This results in a stenotic spinal canal.

This disproportion, in which the spinal canal is too small for its contents, may lead to early neurological changes if hypertrophic arthritis, herniated nucleus pulposus, or kyphosis develops. In appropriate circumstances decompression laminectomy should be done early before irreversible changes occur in the spinal cord.

Thirteen roentgenograms; 5 photographs: 6 diagrams; 2 graphs.

MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Tampa, Fla.

Pelvic Bones in Infantile Mongoloidism: Roentgenographic Features. John Caffey and Steven Ross. Am. J. Roentgenol. **80:** 458–467, September 1958. (Babies Hospital, New York, N. Y.)

In 48 mongoloid infants twelve months of age and younger, the pelves presented a tetrad of characteristic roentgenographic findings: (1) bilateral flattening of the lower edges of the ilia, measured as the "acetabular angle"; (2) bilateral widening and flaring of the iliac wings, measured as the "iliac angle"; (3) bilateral smallness in caliber and gradual taper of the ischial rami; (4) bilateral coxa valga.

The two first named features are prominent immediately after birth, when the clinical diagnosis of mongoloidism is most uncertain. Statistical analysis of the angle measurements in the authors' cases indicates a very high degree of significance.

The two last named features are not well developed prior to the sixth month of life. They are thought to result from poor pelvic musculature.

Twenty-seven roentgenograms; 2 diagrams; 3 charts; 2 tables.

MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Tampa, Fla.

Generalized Primary Calcification of the Surface of the Articular Cartilage, with Demonstration of the True Joint Space. H. Mühr. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 650–655, June 1958. (In German) (Herderstrasse 32, Erfurt, Germany)

The author reports the case of a 33-year-old man with extensive deposits of calcium in the cartilages of

most of the larger joints. Only the surface of the cartilage showed the calcific deposits while the basal layers remained radiolucent, thus producing a double outline of the joint surface and demonstrating the true joint space. These changes could be demonstrated in the shoulder, elbows, hands, hips, knees, and feet. In the knees the menisci were completely calcified. Also, the symphysis and the sternoclavicular and acromioclavicular joints were involved. The fingers and toes remained free. Extensive laboratory tests and blood chemistry studies showed only minor deviations from normal.

The reports of pathological calcification of cartilage in the literature concern mostly the meniscus in the knee joint and the intervertebral disks. The deposit of calcium is dependent upon the *p*H value. As in poorly nourished tissues the *p*H tends to shift toward the alkline side, calcifications are more likely to be found there. Causative factors mentioned in the literature are: mechanical stresses, metabolic disturbances, uremia, sepsis, leukemia, vitamin D intoxication, malaria, etc. The author believes that his case represents a constitutional anomaly.

Ten roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Juvenile Unicameral Bone Cyst: A Roentgen Reappraisal. Gwilym S. Lodwick. Am J. Roentgenol. 80: 495–504, September 1958. (University of Missouri, Columbia, Mo.)

The roentgen appearance of the unicameral bone cyst is that of a passively maintained unilocular cyst epitomizing the completely benign lesion of bone. Some 75 per cent of all true cysts arise in either the proximal humerus or femur. They are usually first found in the metaphysis of the long bone lying juxtaposed to the epiphyseal plate. The shape is that of an elongated truncated cone. The cyst never completely perforates the cortex of periosteum and there is no evidence of active cortical expansion. The maximal diameter is that of the epiphyseal plate. Eventually there may be separation from the plate, which grows away from the cyst making the latter appear to migrate to a midshaft position. Laminated periostosis, Codman's triangle, and spiculation are never seen.

The presence of the cyst in the metaphysis apparently blocks the normal remodeling mechanism, which is promptly restored when (1) the epiphyseal plate grows away from the cyst; (2) when the cyst is successfully treated. The normal diameter of the bone is eventually restored.

Thirteen roentgenograms; 4 diagrams.

MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Tampa, Fla.

Non-Union of the Epiphysis of the Lateral Condyle of the Humerus. C. C. Jeffery. J. Bone & Joint Surg. **40-B:** 396–405, August 1958. (Exeter, England)

Nonunion of the epiphysis of the lateral condyle of the humerus has been observed by the author in three sets of circumstances:

Nonunion After Undisplaced Fracture Separation: Nonunion became established in one case under the authors' observation in which the original radiograph showed a mere fissure of bone. Treatment was by support with a sling for three weeks. Symptoms disappeared completely and movements returned to normal, but later radiographs showed failure to unite and lateral displacement of the epiphysis. The author presents evidence which indicates that many cases of nonunion of the epiphysis of the lateral condyle of the humerus arise as the late result of quite minor epiphyseal displacement. These may progress unrecognized to nonunion, often with increasing deformity.

Nonunion After Closed Reduction: Imperfect closed reductions must be critically assessed with a strong bias toward open reduction and screw fixation. Closed reduction may be attempted provided there is no rotation of the epiphysis. Even after good reduction by direct digital pressure, the difficulty of holding the displaced fragment of bone firmly and exactly in position by plaster may be a major factor in determining nonunion. Two cases with failure of union after five and six weeks immobilization, respectively, are cited.

Nonunion After Operative Reduction: Three cases of nonunion are described in which major displacement was reduced by open reduction and secured by soft-tissue suture. The author contends that any displaced fragment should be stabilized, if possible, by internal screw fixation. He believes that such fixation provides an accurate and stable reduction which cannot be matched by soft-tissue suture.

Considerable emphasis is placed on serial follow-up radiographic examinations; union of displaced lower humeral epiphyses must be established unequivocally by radiographs. If adequate radiographic studies are insisted upon, delayed union can be recognized and steps can be taken to expedite union, thus preventing the increasing displacement and deformity that may otherwise occur. In particular, frequent follow-up radiographs are necessary after closed reductions to exclude redisplacement during the period of immobilization.

Thirty roentgenograms.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Torsion of the Femur: A Follow-up Report on the Use of the Dunlap Method for Its Determination. A. R. Shands, Jr., and Marshall K. Steele. J. Bone & Joint Surg. **40-A:** 803–816, July 1958. (P. O. Box 269, Wilmington, Del.)

Measurements of torsion of the femoral neck were made on 584 patients by the method of Dunlap (J. Bone & Joint Surg. **35-A:** 289, 1953. Abst. in Radiology **62:** 300, 1954). In 238 normal children, the anterior angulation of the femoral neck with respect to the femoral shaft diminished with age, with an average of 39° under age one year, 31° at two years, 24° at ten years, and 16° at sixteen years. Eighty-one per cent of the readings fell within 10° of the average normal.

Of 45 patients with congenital hip dislocation, only 4 had a normal angle of torsion. In the others, torsion ranged up to 82°, with 36 per cent of the cases having over 50° of torsion. Study of the nondislocated hip in 34 unilateral cases showed 16 with torsion above the normal range. Three patients followed for two to four years after closed reduction showed considerable decrease in torsion.

Of 92 hips with coxa valga, about half had torsion more than 10° above average.

In 7 patients with coxa vara, 10 hips showed marked

decrease in femoral torsion, with 3 showing a minus torsion (retrotorsion).

Six of 40 hips with coxa plana showed increased femoral torsion.

Twelve roentgenograms; 3 photographs; 2 graphs; 6 tables. GARTH R. DREWRY, M.D.
Tampa, Fla.

Tuberculosis of the Femoral Neck and Greater Trochanter. R. T. Ahern. J. Bone & Joint Surg. **40-B:** 406–419, August 1958. (Heatherwood Orthopaedic Hospital, Ascot, England)

The author reviews 6 cases of tuberculosis of the femoral neck occurring in children from three to nine years of age. Three patients were treated conservatively, and in 2 of these complete recovery ensued, but with radiological evidence of slow healing. In the third patient treated conservatively, tuberculous arthritis developed, with destruction of the joint two and three-quarter years later. The other 3 patients were treated by excision of the focus followed by chemotherapy. All of these made a rapid and complete recovery, with radiologic improvement in three months.

Eight cases of tuberculosis involving the bursa only and 10 cases of tuberculous involvement of the bursa and the trochanter are also analyzed. Treatment consisted of chemotherapy (streptomycin combined with PAS or INH) and liberal exposure of the greater trochanter and thorough debridement. Chemotherapy was continued for six to twelve weeks following surgery, and thereafter full activity was allowed. Results indicate only one failure among the 18 cases.

Nineteen roentgenograms; 3 tables.
RICHARD A. ELMER, M.D.
Atlanta, Ga.

Femoral-Head Phlebography: A Method of Predicting Viability. Anders Hulth. J. Bone & Joint Surg. **40-A:** 844–852, July 1958. (Royal Academic Hospital, Uppsala, Sweden)

The most important vessel supplying the femoral head is the medial femoral circumflex artery running along the posterior side of the base of the neck. Its branches to the head lie within the joint in synovial reflections of the capsule (retinacula) at the superior and inferior edges of the neck. Vessels in the ligamentum teres also undoubtedly contribute to the nutrition of the head. In fractures of the neck the retinacular vessels may be stretched or torn, particularly if the fragments are displaced.

Arteriography is difficult because the retinacular and foveal branches are so small that they are not easily distinguished. The parallel veins are more readily demonstrable. Femoral head phlebography is performed by the author at least three days after injury, at the time of operation, with ordinary portable roentgenographic apparatus. A stainless steel tapered cannula 10 mm. long, with an outer diameter of 3.2 to 5 mm., is driven through the greater trochanter, across the fracture line, and well into the head fragment. Two milliliters of 35 to 50 per cent Umbradil is injected in about eight seconds, and anteroposterior and lateral views are obtained immediately after the injection. "Positive" venograms show immediate filling of the retinacular or foveal veins or both. In "negative" venograms the veins do not fill, the contrast material remaining in the cancellous bone of the head or flowing out into the fracture, indicating avascularity.

In 12 trochanteric fractures, the vascularity was found to be good. Of 16 nondisplaced neck fractures, only 2 were avascular. Of 82 displaced (varus) neck fractures, 19 had filling of the circumflex veins, with or without ligamentum teres vein filling; 33 had a ligamentum teres type of venogram only (mainly patients over seventy-six years old); 13 had negative venograms indicating avascularity; and 17 had atypical patterns or false negatives due to improper placement of the cannula.

Follow-up of 43 of the displaced fractures for at least a year showed that in all 12 of those with negative venograms early signs of necrosis developed, with nonunion of the fracture or resorption of the head. In 10 of 31 patients with positive venograms, some avascularity, particularly in the upper portion of the head, developed, but the fractures usually united. Thus the author feels that this method makes possible the early definitive diagnosis of avascularity in at least half of the patients in whom it will later appear.

Twelve roentgenograms; 1 photomicrograph; 1 photograph; 1 table. GARTH R. DREWRY, M.D.
Tampa, Fla.

A Study of Experimental Trauma to the Distal Femoral Epiphysis in Rabbits—II. J. Albert Key and Lee T. Ford. J. Bone & Joint Surg. **40-A:** 887-896, July 1958. (L. T. F., 4952 Maryland Ave., St. Louis 8, Mo.)

Various types of experimental trauma were administered to the lower femoral epiphysis of rabbits three to four weeks old. Seventeen to twenty-one weeks following operation the bones were examined by roentgenograms, dissection, and microscopic sections.

The following observations were made:

Placing a small Vitallium nail across the epiphysis does not appear to interfere with growth of the bone.

Curetting the lateral portion of the periphery of the epiphyseal cartilage results in a valgus deformity and moderate shortening of the femur.

The elevation of a flap of bone, including a portion of the epiphyseal cartilage, will likewise result in some interference of activity of that portion of the epiphysis and will result in a valgus deformity with moderate shortening of the femur.

Placing bone wax and croton oil in a metaphysis of the femur results in its shortening, with an osteomyelitic reaction but does not stimulate growth of the bone.

Placing bone wax and croton oil in a drill hole in the lateral condyle of the femur likewise does not stimulate growth of the epiphyseal cartilage.

This paper supplements an earlier one describing three types of experimental trauma to the lower femoral epiphysis in rabbits. (J. Bone & Joint Surg. **38-A:** 84, 1956. Abst. in Radiology **67:** 785, 1956).

Sixteen roentgenograms; 3 photomicrographs; 4 tables. GARTH R. DREWRY, M. D.
Tampa, Fla.

GYNECOLOGY AND OBSTETRICS

The Hysterographic Appearance of Cystic Glandular Hyperplasia. Per Bergman and Lennart Wehlin. Acta radiol. **50:** 255–260, September 1958. (Allmänna Sjukhuset, Malmö, Sweden)

Metropathia haemorrhagic cystica is a common dis-

case usually presenting a typical history of periods of amenorrhea of varying duration followed by protracted bleeding, although the menstrual timetable is sometimes fairly normal. The authors' material consisted of 35 histologically verified cases of cystic glandular hyperplasia. All of the hysterographic examinations were made with water-soluble contrast media.

The hysterographic appearances in the condition vary widely. In the majority of the cases the findings were normal; only 14 of 35 cases had hysterographic features of endometrial hyperplasia. Similar changes are sometimes seen in other intrauterine disorders, such as carcinoma of the uterus and endometrial tuberculosis, and there were found to be no pathognomonic features in the roentgenologic appearances of cystic glandular hyperplasia. Even in the same patient the hysterographic picture may vary from one occasion to another.

Six roentgenograms.

THOMAS R. MARSHALL, M.D.
Indiana University Medical Center

The Role of Gynecography in the Evaluation of the Infertile Woman. Irving F. Stein, Sr. West. J. Surg. 66: 262–267, September-October 1958. (111 N. Wabash Ave., Chicago 2, Ill.)

Gynecography includes pneumoperitoneum with carbon dioxide alone and hysterosalpingography with opaque media.

Hysterosalpingography is employed chiefly to confirm or establish tubal patency; it will also demonstrate hydrosalpinx (pearl cluster) or other forms of tubal occlusion or obstruction. Intrauterine malformations, such as septate uterus, submucous fibroids, polyps, carcinoma, retained tissues, incompetent cervix, may also be visualized with the use of opaque media. Hysterosalpingograms reveal the size and shape of the uterine cavity, abnormalities in the interior of the uterus and lumina of the fallopian tubes, and intraperitoneal spill when the tubes are open. If tubal obstruction is present in one or both tubes, only the first point of obstruction encountered may be indicated, however. Cause of tubal closure cannot be shown by this method alone, nor can one differentiate between thickened, adherent, or otherwise diseased tubes beyond the point of obstruction. The author therefore prefers to combine hysterosalpingography with pneumoperitoneum, either transuterine or transabdominal, to outline the uterus, ovaries, and tubes, and to record on the x-ray films not only the normal status, but changes in size, shape, and relationships of the pelvic organs.

Early pregnancy can be demonstrated by pneumoroentgenography, as can partial tubal abortion, small growths (single or multiple, submucoid or within the uterus), cysts, and other disease conditions.

The article closes with a detailed technic for the complete visualization of the pelvic organs.

Six roentgenograms.

THE GENITOURINARY SYSTEM

Micturition Cysto-Urethrography: Automatic Serial Technique. C. E. Gudbjerg, L. Kuld Hansen, and E. Hasner. Acta radiol. **50:** 310–316, September 1958. (Rigshospitalet, Copenhagen, Denmark)

Voiding cysto-urethrography gives information regarding the bladder floor and internal orifice, the base and sphincter, bladder position, vesico-ureteral reflux, and residual urine. The authors recount their experience in a material of 100 cases in which automatic serial exposures were made.

The patient is prepared for examination by completely emptying the rectum and draining the bladder with a soft, nonirritating rubber catheter lubricated with xylocaine gel, which serves the dual purpose of lubricant and anesthetic. The bladder is then filled, to the point of eliciting the voiding reflex, with 100 ml. of 45 per cent diodone diluted to 15 per cent with 200 ml. of sterile water (in children two-thirds of these quantities are used). This gives adequate density without irritation.

One film is obtained before micturition is begun, followed by others at three- to five-second intervals according to the rate at which the bladder empties, the strength of the urinary stream, and the amount of fluid previously introduced into the bladder. Care is taken to make one exposure immediately before the completion of micturition and one or perhaps more immediately afterward. The tube distance is 90 cm., the central beam being directed 5° cranially from the upper margin of the symphysis. The authors stress the importance of creating the most favorable conditions, so that micturition will be entirely unrestrained: the room should be quiet, the light subdued, and the patient should preferably be alone.

Both the skin and the gonads may be spared much radiation by the use of high-voltage technic—110 to 120 kv rather than the usual 30 to 90 kv. Molded lead shields for the testes have brought about further reduction in male patients.

Two tables.

SAUL SCHEFF, M.D.
Boston, Mass.

Vasoseminal Vesiculography in Hypertrophy and Carcinoma of the Prostate. Gunnar W. Vestby. Acta radiol. **50:** 273–284, September 1958. (Ullevål Hospital, Oslo, Norway)

Vasoseminal vesiculography is an old but seldom used diagnostic tool. It was first described by Belfield in 1913. The purpose of this paper is to discuss the radiographic findings in the ejaculatory duct and the contiguous part of the spermatic tract in cases of hypertrophy and carcinoma of the prostate.

The technic of the procedure is described. In the Ullevål Hospital, from which this report comes, vasectomy is performed in most patients with prostatic disease, and vesiculography is carried out in connection with that operation. Anesthesia is unnecessary and complications have been few.

The author's material comprised 126 cases of prostatic hypertrophy and 32 cases of carcinoma.

It was found that in hypertrophy the ejaculatory duct is always more or less dilated, even up to several times the normal dimensions. The normal contraction rings are frequently more or less well preserved. There is thought to be a correlation between degree of hypertrophy and dilatation of the duct, *i.e.*, the greater the extent of the hypertrophy the greater the dilatation. Ejaculatory ducts are generally symmetrical; however, if there is more hypertrophy on one side of prostate that duct may be more dilated. Asymmetry, therefore, does not exclude hypertrophy. Generally, the seminal vesicle is enlarged and dilated in hypertrophy of prostate.

In carcinoma of the prostate the radiographic findings

are practically the opposite to those in hypertrophy. The ejaculatory duct is greatly narrowed unilaterally or bilaterally. The contour of the duct is irregular, rigid, and infiltrated. The contraction rings are lacking. As carcinoma becomes extensive, the excretory duct, ampulla, and seminal vesicle assume rigid contours and show signs of irregular infiltration. Also in advanced cases of infiltration the ejaculatory duct may become stenosed and too high an injection pressure may cause rupture, with escape of contrast material into surrounding tissues.

Changes due to inflammatory conditions are discussed. These include gonorrhea, tuberculosis, and chronic prostatitis. Only occasionally did such changes cause difficulty in differential diagnosis.

It is concluded that characteristic radiographic signs make it possible to establish a definite diagnosis in approximately 90 per cent of cases of benign hypertrophy and cancer of the prostate. Approximately 10 per cent of carcinomas are missed because small carcinomatous nodules may not have yet infiltrated the ejaculatory duct.

Thirteen roentgenograms; 3 diagrams.

EARL R. BROWN, JR., M.D.
Indiana University Medical Center

TECHNIC

Isolated Fluoroscopy: An Evaluation. Robert S. Sherman and William G. Cahan. New England J. Med. **259:** 622–625, Sept. 25, 1958. (Memorial Center for Cancer and Allied Diseases, New York, N.Y.)

The authors define isolated fluoroscopy as the use of routine fluoroscopy as the sole method of x-ray examination to detect, confirm, or follow the progress of a lesion. Among the objects of this detached method of examination is the confirmation of knowledge achieved by coupling the history with physical diagnosis. It may also bring to light undetected lesions of the heart or lungs. It is used, too, in studies of foreign bodies, cardiac disturbances, gastrointestinal disease, fractures, bone age, and a wide variety of abnormalities.

There is probably little argument against the screening for following known abnormalities and studying the course of disease or of therapeutic effect. It is said to be more convenient, faster, and cheaper than film coverage. It imparts an authoritative air to the examination. Teaching, tradition, and custom enter into the picture, as does the competitive spirit among physicians, and sometimes the urging of the patient. Remote geographical location and specialized interests may dictate the choice of isolated fluoroscopy.

The most fundamental motive for the use of isolated fluoroscopy remains the attempt to uncover an abnormality, after which a regular radiological examination may be pursued. But this leaves us with the premise that if no change is seen on the screen, no abnormality exists. The flaw is that lesions must be fairly large to be demonstrable, fluoroscopically—5 to 10 times the size of a lesion visible on film. This serious lack of detail is especially noteworthy in bone and lung lesions but is true to an almost equal degree of heart, mediastinal, and other abnormalities.

Isolated fluoroscopy is further hampered by the absence of a permanent film record, which is poorly replaced by diagrams or notes. Future comparison then becomes a largely personal matter. Again, since fluoroscopic machines are so frequently used by the uninitiated, or at best, poorly trained, the results of necessity suffer. Fluoroscopy without full accommodation is at the least a breech of the patient's trust, if not criminal. Can the physician spend twenty minutes to become dark adapted? Can the hurried screening examination, out of respect to the physician's time or in deference to the radiation hazard, compete with a calm, objective analysis of a film that even permits the opinion of a colleague or consultant?

Screening by the attending physician often carries with it bias from the close clinical relationship, with a lowering of objectivity. This results in both over- and underdiagnosis. Overdiagnosis leads to unnecessary further examinations while underdiagnosis covers all with a false mantle of security.

Screening, especially in untrained hands, presents a real radiation hazard since some machines deliver as high as 100 r per minute in contrast to 0.05 r conveyed by a well protected unit in taking a postero-anterior chest film. Fluoroscopy, when indicated, can be kept to an absolute minimum only when integrated with films.

The steps necessary to relegate isolated fluoroscopy to the realm of outmoded medical practice because of its unsoundness and hazards will probably proceed from five sources: teaching centers; the radiologist; organized medicine, which may become a regulatory force to banish unnecessary, unsound, and dangerous x-ray practices; governmental interest in public health; finally, the equipment manufacturers, who should continue research in an attempt to improve the quality of their products from the point of view of both diagnosis and protection.

SAUL SCHEFF, M.D.
Boston, Mass.

Focal Spot Sizes. F. H. Kemp and A. F. Nichols. Brit. J. Radiol. **31:** 486–488, September 1958. (United Oxford Hospitals, Oxford, England)

The unsharpness due to small differences in focal spot size is not usually detected in examination of a variety of films, but when radiographs of one type of examination which have been taken on the same x-ray apparatus with different tubes are compared, this is readily apparent. If the structure to be examined lies close to the film, however, the blurring of overlying details due to a large focal spot may be an advantage. A picture is given of a pinhole device which can be attached to an x-ray tube for a film of the focal spot. Off-focus radiation, which also contributes to blurring, is not measured in this type of examination.

Sixty-three focal spots were measured and 58 were found larger than their declared size. The focal spots of rotating anode tubes were on the average 146 per cent oversize and of stationary anode tubes 55 per cent. It is suggested that the foci of tubes manufactured twenty years ago were closer to their declared size than those at present in use.

Focal spot sizes measured by a standard technic should be correctly stated on the tube shield and each tube should be provided with a realistic rating chart.

One photograph; 2 tables.

LUCILLE DU SAULT
The Henry Ford Hospital

Precise Measurements of Focal Areas in Diagnostic X-Ray Tubes and Their Applications in Tube Development. C. W. Robertson and G. Watson. Brit. J. Radiol. **31:** 489–491, September 1958. (Solus Electronic Tubes Ltd., London, W. 1, England)

In a pinhole radiograph of the focal spot, a geometri-

cal blur is produced by the finite size of the pinhole itself. Visual measurements by different observers show the greatest variations when film density is low and the blur is large. A film density of 1.0 has been found satisfactory. Blur is negligible with a pinhole diameter of 0.025 mm. for focal spots between 0.3 and 1.0 mm. and 0.05 mm. for sizes between 1.0 and 2.0 mm.

The intensity of radiation through a pinhole falls off as the angle of incidence is increased. Thus material with a high absorption coefficient should be used for the diaphragm. Also, the pinhole must be easily produced, and retain its size and shape. Tantalum is a suitable material. If it is necessary to use a thick diaphragm, the pinhole can be conical.

Two charts. LUCILLE DU SAULT
The Henry Ford Hospital

Some Considerations of Focal Spot Sizes. A. Beetlestone and G. Thurmer. Brit. J. Radiol. **31:** 492–496, September 1958. (Mullard Limited, London, England)

The size of a focus for a given rating is determined by the target angle and the acceptable decrease of x-ray output with tube life as a result of target roughening and evaporation. It is not practical to decrease the target angle much below 15° if a satisfactory dose distribution is to be maintained during the useful life of the tube, and most manufacturers have standardized on 16 1/2°. If focal sizes are to be reduced without decreasing the rating, the price is shorter tube life. If this were 10,000 exposures, instead of 20,000, the cost of the radiograph would be increased 2.6 per cent.

The maximum unsharpness is determined by the longest dimension of the focal spot. It is proposed that half of this dimension be used to designate focal spot size. Then existing foci could be referred to by the same numerals which now describe their normal size, but with a much greater approximation to the truth.

The American standard has excessive tolerances, and a 1-mm. focal spot may vary between 0.9 and 1.6 mm., a difference in area of 3.16 times.

Seven figures. LUCILLE DU SAULT
The Henry Ford Hospital

The Estimation of Dry Skeletal Weight by Photometry of Roentgenograms. Paul T. Baker and Harald Schraer. Human Biol. **30:** 171–184, September 1958. (Biophysics Laboratory, The Pennsylvania State University, State College, Penna.)

This paper reports the progress in developing a method for predicting the dry skeletal weight of a man from roentgenograms of the humerus or femur. Eleven human femurs, taken from an anatomical collection, were dried to a constant weight at a temperature of 70° C. They were then weighed and exposed—together with the calibration standard: a wedge of aluminum alloy—on nonscreen films in cardboard holders. A total of 21 trace paths along the shaft, and a single path along the midshaft, were evaluated twice with the *bone density computer*, which is a combination of a tracing densitometer, an integrating device, mass counters, and a data recording device. The values given for the mass coefficient of the bone, in terms of aluminum alloy for the sections of film studied, were then correlated with the dry weight of the bones, and analyzed statistically for the entire material. It appeared that the single trace path across the midshaft was sufficiently accurate to predict total femur weight.

A similar method was applied to the study of the right humerus and right femur from the skeletons of 61 whites and 17 Negroes among Korean war dead. In these cases, comparison was made with the dry (defatted) weight of the entire respective skeleton. The Korean material showed that the weights of the femurs and humeri would accurately predict total skeletal weight for the whites and, with limited accuracy, for the Negroes. An evaluation of the roentgenograms of their humeri and femurs predicted the individuals' total dry skeletal weight with a standard error equal to approximately one-half of the standard deviation of dry skeletal weight. However, the results thus obtained cannot yet be used in the living, because of interposition of soft tissue. A corrective factor is now under study: if this is successfully determined, the procedure will offer a fairly accurate method for measuring one of the important components of the body.

Four charts; 4 tables. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

RADIOTHERAPY

A Report of 549 Cases of Breast Cancer in Women 35 Years of Age or Younger. Norman Treves and Arthur I. Holleb. Surg., Gynec. & Obst. **107:** 271–283, September 1958. (Memorial Center for Cancer and Allied Diseases, New York, N. Y.)

An analysis was made of 549 patients, thirty-five years of age or younger, with histologically confirmed breast cancer, who were seen at the Memorial Center for Cancer from 1937 through 1949. The minimum five-year clinical cure rate was 30.7 per cent, indicating that breast cancer in young women offers a prognosis equal to that in older women. This is in contrast to the general belief that the prognosis is worse in young women. However, when axillary node involvement was present, the clinical cure rate was lower than in older women, suggesting that the disease might be more lethal when regional metastases have occurred in the younger patient. Of particular interest to the radiologist are the results of the following analyses:

Postoperative Roentgen Therapy: Postoperative roentgen therapy, in this series, regardless of axillary node involvement, had no influence on the clinical cure rates. A chart of the results follows:

Postoperative X-Ray Therapy and Clinical Cure Rates: 368 Patients

	No. patents	Died	5-yr. clinical cure
Positive axillary nodes	219	167	52 (23.7%)
X-ray therapy	175	135	40 (22.8%)
No x-ray therapy	44	32	12 (27.2%)
Negative axillary nodes	149	57	92 (61.7%)
X-ray therapy	44	20	24 (54.5%)
No x-ray therapy	105	37	68 (64.7%)

Castration: No comparison could be made between the effectiveness of surgical castration and pelvic irradiation. The median duration of survival following

therapeutic castration for metastatic breast cancer was nine months. When the axillary nodes were uninvolved, prophylactic castration did not affect the clinical cure rates. With involvement of axillary nodes, the five-year clinical cure rate was 8.3 per cent higher in those patients who were castrated prophylactically.

Twenty-two tables. MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Results of Therapy of Cervical Carcinoma, 1948–1952, Within the Scope of Therapeutic Results of a Thirty-Year Period. Ernst Philipp and Karl Rumphorst. Strahlentherapie **107:** 78–84, September 1958. (In German) (Universitäts-Frauenklinik Kiel, Germany)

At the University of Kiel, 2,456 cervical cancers were treated from 1922 to 1947, with a cure rate of 32.7 per cent. From 1948 to 1952, 822 cervical cancers were treated with 352 cures, or 42.8 per cent.

In the later period 220 cases (27.5 per cent) were treated by surgery alone and 580 cases received a combination of internal and external irradiation. This material included 12 per cent Stage I cases, 30 per cent Stage II, 53 per cent Stage III, and 5 per cent Stage IV. The five-year cures were as follows: Stage I, 86.7 per cent; Stage II, 62.9 per cent; Stage III, 27.3 per cent; Stage IV, 0.

In 207 cases in which vaginal hysterectomy was done, the primary mortality was 1.4 per cent, and the five-year cure rate was 62.9 per cent. Before 1947 the primary mortality had been 4.5 per cent. Since 1953, no operative fatalities have occurred. Abdominal hysterectomies were done in 13 cases because of fibroids or pregnancy. The five-year cure rate for this group was 61.8 per cent.

The five-year cures for radiation therapy were as follows: Stage I, 91.7 per cent; Stage II, 70.9 per cent; Stage III, 27.5 per cent; Stage IV, 0. There has been a 10 per cent improvement as compared with the period from 1922 to 1947.

The authors used the Stockholm method, with three radium insertions combined with external radiation therapy.

It is believed that the present improvements in the treatment results are mainly due to the fact that more early cases are being treated today and to better operative technics. In order to improve cure rates further, we must have better methods of early diagnosis.

Two charts; 6 tables.

EUGENE F. LUTTERBECK, M.D.
Chicago, Ill.

Pelvic Lymph Node Dissection Following Radiotherapy. Mary Jane Gray, Saul B. Gusberg, and Ruth Guttmann. Am. J. Obst. & Gynec. **76:** 629–633, September 1958. (College of Physicians and Surgeons, Columbia University, New York, N. Y.)

Of 72 patients receiving primary radiotherapy for carcinoma of the uterine cervix (Stages I to III) from 1952 through 1956, 55 were subjected to pelvic lymphadenectomy. Of 51 patients in Stages I and II, only 1 (2 per cent) was found to have positive nodes at lymphadenectomy. A comparative group of 61 Stages I and II cases treated primarily with radical hysterectomy revealed 11 cases or 18 per cent with positive nodes. Positive nodes were found in 2 of the authors' Stage III cases.

Radiotherapy in this series had consisted in 6,000 mg. hr. of radium with an additional tumor dose of 3,500 r with 250-kv. or 5,000 r with supervoltage roentgen rays.

In 20 patients major complications followed lymphadenectomy and an additional 21 had minor complications. The following conclusions are reached:

"1. Pelvic lymph node dissection after full radiation treatment for cancer of the cervix carries a prohibitive morbidity and is not therapeutically sound.

"2. Modern radiation therapy appears to have the capacity to destroy metastatic cervical cancer in pelvic lymph nodes, leaving a residue too small to warrant an adjuvant surgical approach to them.

"3. The combination of radical radiation treatment and radical surgical treatment is very traumatic."

Three tables. ROBERT L. EGAN, M.D.
University of Texas, Houston

Environmental Influences on Healing of Cervical Carcinoma. Paul Hess. Strahlentherapie **107:** 127–132, September 1958. (In German) (Strahlenabteilung des Krankenhauses Bethesda, Duisburg, Germany)

The results of treatment of cervical cancer depend not only upon medical but also on social factors. The Bethesda Hospital (Duisburg, Germany) treated a total of 317 cancers of the cervix from 1934 to 1953. Methods of therapy were not materially changed during these years, but the results showed considerable differences.

One hundred and thirty-one cases were treated before World War II, from 1932 to 1942, with a five-year cure rate of 46.5 per cent. In the war period, from 1943 to 1948, when social conditions were poor, 83 cases were treated, with a five-year cure of only 30 per cent. During the postwar period, from 1949 to 1953, there were 103 cases, with a five-year cure of 48 per cent.

The author comes to the conclusion that the results of therapy in cervical cancer parallel the improvement or deterioration of social conditions.

One graph; 6 tables.

EUGENE F. LUTTERBECK, M.D.
Chicago, Ill.

The Argument Against Preoperative Radium for Endometrial Cancer. Chas. E. McLennan. West. J. Surg. **66:** 193–198, July-August 1958. (Stanford University School of Medicine, San Francisco, Calif.)

In this paper the author concludes that the best argument *against* preoperative intracavitary radium for adenocarcinoma of the endometrium is the fact that there is no convincing argument *for* it. He cites several reports in which the five-year survival rates of patients with total hysterectomy alone were as good as those treated with preoperative radium and hysterectomy. Special attention is called to a paper by J. Chandler Smith (J.A.M.A. **160:** 1460, 1956. Abst. in Radiology **68:** 304, 1957), who made the point that preoperative radium provides no practical advantage over hysterectomy alone in the eradication of tumor cells. If the carcinoma is superficial, radium alone may be curative and subsequent hysterectomy is unnecessary. If the cancer is deep, radium alone is not curative, and hysterectomy must be performed. But because depth of tumor cell penetration cannot be defined at the onset of treatment, hysterectomy is obligatory in any event. Preoperative radium therefore makes no tangible contribution to cure.

Since there is no convincing evidence that preoperative radium improves the end-results of treatment, this economically wasteful practice should be abandoned.

Two tables.

JAMES A. BURWELL, M.D.
Mercy Hospital, Pittsburgh, Penna.

Prognosis in Neuroblastoma of Childhood. Wataru W. Sutow. J. Dis. Child. **96:** 299–305, September 1958. (M. D. Anderson Hospital, Houston 25, Texas)

Data obtained from reports in the literature published since 1950 along with clinical observations on 15 cases of neuroblastoma in children seen at the M. D. Anderson Hospital from 1951 through 1957, are analyzed in an attempt to evaluate the possible prognostic significance of age, sex, site of primary tumor, presence of metastases, degree of cytologic differentiation, and definitive therapy. The combined series of 496 children is divided arbitrarily into two groups, those under two years of age and those over two years of age. For the purposes of this study, prognosis is measured in an arbitrary term of fourteen months survival or longer following diagnosis.

The age at the time of diagnosis seems to be an important factor in prognosis: children under two years showed a 40 per cent survival rate while of those over two years only 7.5 per cent lived fourteen months or longer. Sex and the site of the primary tumor did not appear to have any significant statistical relationship to the prognosis.

Nearly three-fourths of the children had evidence of metastasis when first seen. Skeletal metastases, in particular, indicated a poor prognosis, and these were significantly more frequent among the children over two years of age. Prognosis seemed uniformly poor in that group, however, whether or not metastases were present initially. In the younger age group, children with extra-skeletal metastases showed the same survival rate as did those with no metastases.

Evaluation of survival based on the type of therapy was inconclusive because of the numerous variables in selection of cases for treatment and in the type of treatment administered. The conclusion is that children who received no therapy showed a significantly lower survival rate than did those who received therapy, of whatever form (surgery alone, radiotherapy alone, or a combination of the two).

A study of the degree of cytologic differentiation indicated that the survival is significantly higher when the tumors are differentiated.

In summary, it is felt that age over two years, presence of skeletal metastases, and tumor undifferentiation are important factors associated with poor survival rates. The data from which these conclusions are drawn are presented in extensive tables.

Seven tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Supervoltage Radiation for Sarcomata of the Pelvis and Lower Extremities: A Preliminary Report. G. Edmund Haggart, David O. Johnston, and Francis Creeden. J. Bone & Joint Surg. **40-A:** 870–876, July 1958. (605 Commonwealth Ave., Boston 15, Mass.)

Twelve cases of sarcoma of the pelvis or lower extremity treated with the two-million-volt Van de Graaff generator are reported. Rotation therapy was used in some cases and opposing portals in others.

Six chondrosarcomas of the pelvis or femur received a usual tumor dose of about 6,000 r (duration of treatment not stated). One patient survived over ten years after his original treatment, dying of renal failure due to obstruction by tumor. During the long survival period multiple surgical procedures were performed for local extension and recurrences, and repeated courses of irradiation were given. Three patients were alive and well up to twenty-two months after treatment.

Two patients with fibrosarcoma of the thigh and buttock received a 7,500 r tumor dose and were alive and well at the time of the report, forty-six and thirteen months after treatment, respectively.

A fifty-five-year-old man who received a 3,000 r tumor dose for reticulum-cell sarcoma of the acetabulum was well sixty-nine months after treatment.

A twenty-four-year-old woman with Ewing's sarcoma of the fibula and a later inguinal metastasis received treatment over a one-year period to the leg, chest, thigh, hemipelvis, midline of the abdomen, and mediastinum. She remained well eighty months after the initial treatment and had had 5 normal pregnancies.

Complications of treatment were proportional to the dose. Fibrosis of subcutaneous and deep tissues occurred in several patients. The resulting leg edema was controlled by an elastic stocking. No radionecrosis of skin and no pathologic fracture occurred.

Three drawings; 1 table.

GARTH R. DREWRY, M.D.
Tampa, Fla.

Radiation Therapy of Solitary Benign Cystic-Appearing Lesions Involving the Long Bones of Children. James C. Cook, Kenneth L. Krabbenhoft, and Robert Songe. Am. J. Roentgenol. **80:** 505–524, September 1958. (Harper Hospital, Detroit 1, Mich.)

In this day when the trend is away from radiotherapy of benign lesions the authors present a compelling argument for the place of radiation therapy in certain cases of cystic lesions in the long bones of children. These lesions are classified and the confusing terminology handed down from various authors over the years is clarified. The authors report 15 cases treated with favorable results in their own clinic.

There is a feeling among physicians who deal directly with these problems that indiscriminate biopsy of all lesions can sometimes raise more problems than are solved. There is often no general agreement among pathologists as to a specific diagnosis and at times not even a decision as to benignancy or malignancy can be made. Biopsy and curettement can lead to a certain amount of morbidity and entail complications. In "active" solitary bone cysts there is danger of surgical damage to the epiphyseal plate. It is also the belief of many experienced observers that if true sarcoma is present, early and radical surgical procedures do little to change the miserable prognosis.

In the authors' experience protracted roentgen therapy, with relatively small doses, produced excellent results with less deformity than could be expected from surgery in the active or acute bone cyst in metaphyseal location. In the series reported, the average tumor dose was 1,182 r delivered in small fractions (200 kvp; 1.5 mm. Cu plus 1.0 mm. Al filtration; 0.9 mm. Cu h.v.l.; 13 r per minute). Small fields were used, and a target-skin distance of 50 cm. The maximum total tumor dose recommended is 1,200 r, and usually much less will be adequate. The growing metaphysis is protected in all cases if possible.

The exact type of cystic lesion appeared to be unim-

portant; all types treated by the authors responded in a roughly similar fashion. These included lesions ultimately diagnosed as solitary bone cyst, giant-cell tumor, osteitis fibrosa cystica, aneurysmal bone cyst, and benign chondroblastoma.

When the desired result is not achieved by small amounts of radiation, successful surgical intervention can be carried out subsequently.

Forty-eight roentgenograms; 1 drawing; 2 tables.

MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Tampa, Fla

The Beta-Mosaic: An Adaptable Radiation Source for Superficial Radiation Therapy. Josef Becker and Kurt Ernst Scheer. Strahlentherapie **107:** 112–116, September 1958. (In German) (Czerny-Krankenhaus für Strahlenbehandlung der Universität Heidelberg, Germany)

For the treatment of medium-sized superficial lesions, such as nevi or superficial carcinomas, the authors use a blotter saturated with yttrium 90 and imbedded in a plastic foil. Yttrium 90 has an average energy of 2.23 Mev and a half-life of 2.5 days. In order to adapt this type of therapy to irregular surfaces, multiple hexagons with a diameter of 10 mm. are being used. This material is comercially available in Germany. The area to be irradiated is painted with Mastisol and each source is pasted on the skin according to the size of the treatment field. Dosages have been measured, and a curve is published which gives the time required to deliver up to 1,800 rep in thirty-six hours.

The authors have worked with an output of about 1.5 to 2.5 rep per minute. They believe that the protraction of radiation has a favorable influence upon the result of therapy. Hemangiomas require an average of 2,000 to 3,000 rep in their experience.

One photograph; 1 graph.

EUGENE F. LUTTERBECK, M.D.
Chicago, Ill.

RADIOISOTOPES

Destruction of the Hypophysis with Radioactive Colloidal Chromic Phosphate in Cancer of the Prostate. Philip C. Johnson, Kelly M. West, and Bob J. Rutledge. J. Neurosurg. **15:** 519–527, September 1958. (Radioisotope Service, VA Hospital, Oklahoma City, Okla.)

The authors injected radioactive phosphorus into the pituitary of 6 patients with advanced prostatic carcinoma in order (1) to evaluate the effect of destruction of the pituitary on cancer of the prostate and (2) to investigate the clinical usefulness of this method of pituitary destruction.

A frontotemporal craniotomy was performed and the diaphragma sellae identified. One-half to 1.5 ml. of a solution containing 9 to 10 mc. of P^{32} as colloidal chromic phosphate was injected into the substance of the pituitary gland. Methylene blue was added for the detection of leakage superiorly. The pituitary stalk was severed in 3 cases.

Preliminary studies on autopsy material had shown that the injected material diffused fairly evenly throughout the gland. If more than 1 ml. was injected extravasation occurred posteriorly and superiorly.

Five of the 6 patients had undergone orchiectomy previously. All were refractory to estrogen therapy and required narcotics for pain.

The 3 patients who survived the procedure experienced relief of pain in the bones. One also exhibited objective evidence of remission of tumor growth. Panhypopituitarism was present in 2 of these 3 patients. In 1 this persisted until death, ten weeks after surgery. In the other, the hypopituitarism and diabetes insipidus produced by the procedure disappeared six months after surgery.

It was not possible to measure accurately the radiation dose. The estimate, based on incomplete autopsy data in 2 cases, was between 9×10^6 and 9×10^4 rep. In at least 1 case, this was insufficient, as pituitary function returned six months later. The dose for complete pituitary destruction is not known, but the data in these cases suggest that 10^6 rep may be necessary.

Autopsies were done in 5 cases. Of the 3 cases in which the pituitary stalk had not been divided, 2 exhibited only minimal histologic changes in the hypophysis. In the 2 cases in which the stalk was divided, the hypophysis was completely destroyed.

Because of the 3 postoperative deaths, the rapid disappearance of the radioactivity from the pituitary, and the return of pituitary function in 1 case, the procedure as described here was discontinued. Destruction of the pituitary by irradiation is yet to be proved superior to surgical hypophysectomy.

Three tables.

EUGENE A. CORNELIUS, M.D.
Houston, Texas

A New Method for Handling Radioactive Gold in the Treatment of Prostatic Cancer. William J. Baker, Eugene F. Lutterbeck, Edwin C. Graf, Daniel H. Callahan, and Raymond Firfer. J. Urol. **80:** 189–191, September 1958. (Cook County Hospital, Chicago)

A new method of handling gold for interstitial injection in the treatment of prostatic cancer is described. The technic of administration of the isotope involves three basic problems: the dosage per cubic centimeter of cancerous tissue, adequate distribution of the radioactive material, and protection against radiation hazard.

The authors use a pressure syringe which is mounted on a stand and a 4-foot needle to transport the radioactive material to the site of injection. In the majority of cases the procedure is done under general anesthesia. With the patient in the lithotomy position, a Silverman needle is placed through the perineum up to the tumor area. The obturator of the needle is removed, and a 6-inch No. 20 needle is inserted through the sheath into the tumor tissue. One Silverman sheath is required for each injection.

The authors state that "the average case requires about 25 to 30 millicuries of radiogold in each lobe of the prostate gland in order to deliver a tumor dose of 6,000 to 8,000 gamma roentgens and about 1,000,000 rad from the beta radiation." The dose to the urethra is about 3,000 roentgens.

Physician and operating personnel receive no more than 40 milliroentgens radiation exposure during the treatment of any one patient.

The authors state that injection of radioactive gold is done only as an additional treatment of prostatic cancer and they are aware that only palliation can be expected.

One photograph.

JOSEPH M. WINSTON, M.D.
Hospital of the University of Pennsylvania

Isotope Localization of the Placenta in Placenta Previa. Donald L. Hutchinson, Leslie R. Bennett, and David A. Gean. Surg., Gynec. & Obst. **107:** 370–374, September 1958. (School of Medicine, University of California at Los Angeles, Calif.)

The isotope localization of the placenta in placenta praevia is based on the assumption that the placenta represents a relative pool of maternal blood and that radioactivity over this site following intravenous injection of a radioactive material will therefore be increased. To test this, a study was carried out on 30 patients admitted for elective repeat cesarean section or on patients with third trimester bleeding. The actual placental site was subsequently determined either at cesarean section (25 cases) or vaginal delivery (5 cases).

Five microcuries of radioiodinated human serum albumin were injected intravenously in each case and after a two minute wait, radioactivity measurements were made over the xiphoid (the control area chosen to represent 100 per cent) and 12 anatomical areas over the gravid uterus, half of these lying roughly above the umbilicus and the other half below it. An attempt was made to predict the location of the placenta by noting increases in the radioactive count. These predictions were then compared to the actual location as determined at delivery. When the placenta lay roughly below the umbilicus the general prediction of location was always correct. (Number of cases not stated, although 153 readings were made). The greatest degree of discrimination occurred in the anatomic area of greatest importance, the lower uterine segment.

The technic described is simple and rapid and gives less radiation to the mother and fetus than do standard radiologic procedures. No films need be developed and consultation with a radiologist for interpretation of results is unnecessary.

Four figures; 1 table.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Spectral Distribution of Scattered Radiation from a Kilocurie Cobalt 60 Unit. D. V. Cormack and H. E. Johns. Brit. J. Radiol. **31:** 497–502, September 1958. (D. V. C., University of Saskatchewan, Saskatoon, Sask., Canada)

The radiation emerging from a cobalt therapy unit will contain soft components due to scattering within the source itself and within the collimating device. Calculations were made of the scattered radiation from the Saskatoon unit, which has a source 2.54 cm. in diameter and 1.30 cm. thick of cobalt metal. It was found to be 16.6 per cent of the primary dose, with 12.9 per cent arising from first scatter and 3.7 per cent produced by higher order scatterings.

Calculations were also made for the radiation scattered by the collimator, which is assumed to consist of a tapered conical opening extending from the plane of the source to a plane 60 cm. from the source. With the skin surface 80 cm. from the source, scatter from the collimator amounts to 12.1 per cent of the primary. The spectral distribution of the scatter from the source and the collimator is given, separately and combined.

Using these data, the attenuation of the beam in a lead absorber was calculated and shown to agree with measured values.

Six figures; 1 table. LUCILLE DU SAULT
The Henry Ford Hospital

Acute Effect of Organic Binding of Iodine on the Iodide Concentrating Mechanism of the Thyroid Gland. Seymour H. Wollman and Franklin E. Reed. Am. J. Physiol. **194:** 28–32, July 1958. (National Cancer Institute, Bethesda, Md.)

The authors present results of investigations to detect whether sudden binding of iodine by the thyroid depresses the ratio of the radioiodide concentrations in the thyroid gland and serum (T/S) without appreciable delay, and whether propylthiouracil (PTU) will elevate the T/S when administered after high enough doses of iodide to block binding almost completely.

It was found that organic binding of radioiodine by the thyroid gland of the mouse was blocked within one minute by the intravenous injection of 1 mg. of propylthiouracil (PTU). In mice on a very low iodine diet the T/S was reduced significantly by injection of 1.5 μg of iodide fifteen minutes before intravenous PTU injection. The amount of iodine bound prior to PTU injection was only a small percentage of the total iodine in the thyroid gland. This reduction did not occur in mice with less active thyroid glands. However, in the latter mice, doses of 22.5 μg of iodide or more injected ninety minutes before PTU caused a small but systematic decrease in the T/S when compared at fixed serum iodide concentration with mice given PTU before the iodide. In addition, in these mice given both PTU and iodide the T/S was greater than in mice given iodide but no PTU. It is concluded that the organic binding of iodine causes a decrease in the T/S in mice with active thyroid glands. In addition, PTU increases the T/S in mice in which organic binding of iodine is blocked by iodide.

One graph; 4 tables.

The Absorption, Transport, and Deposition of Fat. Application of a New Method for the Determination of I^{131}-Lipid Activity in Dogs and Man. David Alan Turner. Am. J. Digest. Dis. **3:** 594–640, August 1958; 682–708, September 1958. (Sinai Hospital of Baltimore, Baltimore, Md.)

The changes in plasma-lipid activity and turbidity following the ingestion of 40 gm. of I^{131}-labeled triolein or oleic acid were noted in 300 experiments on human beings. In 15 normal subjects the maximum activity was within 2.5 to 5 per cent of the administered dose per total blood volume. The peak of activity occurred four hours after ingestion of the meal and coincided with the changes in plasma turbidity. In patients with pancreatic steatorrhea the tolerance curves were flat, the lipid activity being less than 1.5 per cent of the administered dose of radioactive triolein with little or no accompanying plasma turbidity. The feeding of radioactive oleic acid or the addition of pancreatic enzyme to the meal greatly increased the plasma lipids.

Destruction of portions of the absorptive surfaces (mucosa) of the small intestine, as in ileitis, effectively decreased the absorption of the tagged lipids. Four patients in the study showed excessive absorptive powers for the activated lipids, their lipid activities measuring three to four times that of the normal group. This alimentary hyperlipemia is differentiated from endogenous hyperlipemia, characterized by creamy, hyperlipemic plasmas even when fasting. In patients with alimentary hyperlipemia the excess fat could be cleared from the plasma with continuous infusion of 100 mg. heparin in 500 ml. isotonic saline.

The author describes a new technic for the separa-

tion of the tagged lipids so that inorganic iodine is not included in the sample. For this purpose 10 per cent potassium iodide solution is used as a diluting agent instead of water. This solution does not remove the I^{131} linked to the lipid but does take out the inorganic ion.

The absorbed fat was shown to be entirely transported in the plasma and not by the red cells. In animal experiments, the greater lipid activity and plasma turbidity in older dogs was believed to be due to an unexplained decrease in the ability to remove fat from the blood. Other animal experiments suggest that triglyceride absorption occurs chiefly in the duodenum and jejunum with fatty acid absorption taking place in the ileum.

Thirty-nine graphs; 9 tables.

SAUL SCHEFF, M.D.
Boston, Mass.

The Life Span of Red Cells in the Rat and the Mouse as Determined by Labeling with DFP^{32} in Vivo. L. M. van Putten. Blood **13:** 789–794, August 1958. (Radiobiological Inst. National Health Research Council, TNO, Rijswijk, The Netherlands.

The red cells of rats and mice were tagged *in vivo* by injection of diisopropylphosphoro-fluoridate (DFP), labeled with P^{32}, and the disappearance of radioactivity from the circulating red cells was determined. From the data obtained, it is concluded that the disappearance of the red cells is linear with time and that the red cells in both rats and mice have a true life span without measurable random destruction.

The life span of the erythrocytes was found to be 60± 3.2 (SD) days in the rat and 40.7 ± 1.9 (SD) days in the mouse. Especially in mice the determination of the red cell life-span with DFP^{32} is a simple procedure.

RADIATION EFFECTS—PROTECTION

The Hazards of Short Wave Radiation. H. R. Schinz. Schweiz. med. Wchnschr. **88:** 380–381, April 19, 1958. (In German) (Kantonsspital Zurich, Switzerland)

Radiotherapeutic departments without a radiation biology laboratory are unthinkable nowadays according to the author, who includes roentgen rays, betatron rays, and atomic rays in his discussion of short-wave radiation. For minimizing the hazards of roentgen rays the following ten points are offered:

1. The best protection is provided by the knowledge of potential danger.
2. Strict protective measures are necessary with periodic control of equipment and operator.
3. Temporary sterilization of females is contraindicated because of potential radiation damage.
4. Roentgen sterilization of males also is unwarranted because in most instances it is only temporary, as regeneration of testicular tissue frequently occurs.
5. Roentgen abortion is hazardous because of danger of infection and is only permissible together with sterilization of the ovaries.
6. In pregnancy roentgenologic studies of the abdomen should be done only when strict vital indications are evident.
7. Thorotrast causes radiation damage and is carcinogenic.
8. Radium may cause late damage and is contraindicated in benign disease; it should be reserved for treatment of malignant conditions.
9. The use of artificial radioactive substances for diagnostic and therapeutic purposes should be restricted, and radioactive wastes of furnaces and hospitals should be prevented from contaminating sewage.
10. Best possible training regarding radiation hazards is essential.

In spite of the hazards of radiation it must be realized that roentgen diagnosis and therapy have become important tools in saving lives. ERNEST KRAFT, M.D.
Northport, N. Y.

An Estimate of the Potential Leukæmogenic Factor in the Diagnostic Use of X Rays. J. H. Martin. M. J. Australia **2:** 157–158, Aug. 2, 1958. (Peter MacCallum Clinic, Melbourne, Australia)

The author attempts to relate the amount of radiation delivered to the bone marrow of the population of Australia in diagnostic procedures to that received from natural sources, in order to assess relative significance.

Some 4,600,000 x-ray examinations are said to be made in Australia in a year. Figures from various sources are utilized to compute the average bone-marrow dose from a wide variety of diagnostic procedures in children and adults. With allowance for screening, the total annual contribution is placed at 1,160,000,000 gram rads, which is equivalent to 130 gram-rads per capita per year, compared to exposure from natural radiation sources of 140 gram-rads per capita per year. These values are then correlated with data published by others, suggesting that the probability of induction of leukemia from radiation exposure lies in the range of 0.000001 to 0.000002 per person per rad per year. The incidence of leukemia referable to diagnostic radiation is thus roughly equivalent to between 3 and 6 cases per million per year. A review of the public health records for the years 1951 through 1955 shows this to be roughly 5 per cent of the total known leukemic cases.

Two tables. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

On Tolerance of Brain Tissue and Sensitivity of Brain Tumours to Irradiation. Martin Lindgren. Acta radiol. Suppl. 170, 1958. (University Hospital, Lund, Sweden)

The records on 71 patients with intracranial glioma who received radiation therapy and came to autopsy were analyzed for radiation effect on tumor and brain tissue. Clinical history and autopsy and histological findings are given in detail for some 15 to 20 patients. Thirteen cases from the literature are combined with 4 from this group to determine a time-dose line for minimal occurrence of brain necrosis. This line extends from 1,885 r in a single treatment, plotted at 0.35 day, through 4,500 r in 30 days, and extends to 100 days. The slope is 0.26, very nearly the slope (0.27) given for tolerance of human skin.

Time-dose values for 5 patients with long survival without clinical symptoms of brain injury all lie close to this line.

Thirty figures; 8 tables. LUCILLE DU SAULT
The Henry Ford Hospital

Common Sense Approach to the Problem of Genetic Hazard Due to Diagnostic Radiology. Report Based in Part on Study of Exposures in a Small American Industrial City. W. Daggett Norwood. J.A.M.A. **167:** 1928–1935, Aug. 16, 1958. (1937 Harris Ave., Richland, Wash.)

Increasing use of radiation in medicine, industry, and defense has come at a time when genetic experimental evidence indicates that there is no radiation exposure threshold for induction of mutations and that the mutation rate per roentgen exposure is higher than it was thought to be. This has resulted in a need to evaluate genetic hazards to whole populations as well as somatic hazards to individuals. This discussion attempts to present a common sense approach to limitation of exposure to the gonads without sacrificing the advantages of diagnostic radiology.

While there is general agreement that any irradiation exposure is harmful from a genetic standpoint, it is not possible to say with any assurance how harmful. [The implication that any radiation exposure is harmful from a genetic standpoint must be questioned. This is not true of radiation exposures in those beyond the child-bearing age nor of exposures of those within or before the child-bearing age when the radiation does not strike the gonads.—J. F. W.] The National Academy of Science and the British Medical Research Council have suggested 30 to 80 r as the range within which a doubling dose (*i.e.*, doubling the mutation rate) is likely to fall. The British study estimates that only about 1 per cent of mutant genes are dominant and cause damage in the next generation. From calculations based on theory, about 10 per cent of germ cells carry a new mutation. Hence, doubling the mutation rate might lead to an increase of one in a 1,000 in the number of harmfully affected children in the next generation. The report estimates that the risk that a pair of parents will produce an imbecile or idiot who survives is about 1 in 500. The increased proportional risk for parents in both of whom the mutation rate has been doubled is about 3 per cent. This means that the risk of having a child with severe mental defects who survives would be 1 in 485. The genetic harm to a population due to radiation is roughly proportional to the total radiation received by the gonads between conception and reproduction. Exposure of 100 young people to 1 r each has essentially the same effect on the germ pool as does exposure of one young person to 100 r.

Following the recommendation in *Handbook 60* on *X-Ray Protection* (National Bureau of Standards, 1955) will aid greatly in reducing exposure to patients, technicians, and physicians. The most important steps are accurate limiting (coning) and filtering of the primary x-ray beam; use of the most sensitive film, screens, developing chemicals, and temperature; use of the highest voltage that will permit a satisfactory film contrast; reduction to a minimum the number of films and screening time of each examination. Gonads should be protected, when possible, by appropriate screening devices. A qualified expert should assist in planning the structural shielding requirements of any new installations or changes in old installations. The expert should also be consulted in the establishment of a monitoring system to determine the exposure for each individual for whom there is any reasonable possibility of receiving more than one-fourth the maximum permissible weekly dose.

Special care should be taken during examinations of any anatomical portion of infants or small children to avoid, if possible, catching the gonads in the primary beam. Fluoroscopic examinations of well babies on routine periodic visits to pediatricians should be discouraged or prohibited, according to Stone (Am. J. Roentgenol. **78:** 993, 1957. Abst. in Radiology **71:** 633, 1958).

A plea is made for differentiation between the genetic importance of those examinations which involve the gonads in the direct radiation beam and the examination in which genetic exposure is relatively unimportant, such as those involving the chest, head, and extremities. Simple changes in equipment and technic may drastically reduce such exposure. Estimates of genetic damage from radiation are based almost strictly on experiments with fruit flies and mice. The hazards must be weighed against the great lengthening in life—nineteen years during the present century—to which diagnostic radiology has been an important contributor.

Included in this paper is an account of a four-year (1953–56) survey made in Richland, Washington (population, 26,740), the resident community for the employees of the Hanford Atomic Products Operation. About 85,000 diagnostic examinations made in this period are classified according to age, sex, and part of the body examined. The gonadal doses received were calculated with the aid of appropriate phantoms. The genetically significant gonad exposure from natural sources and from man-made radiation is shown in a table and compared with the figures of the National Academy of Science for the United States.

A further report on the Richland study, including detailed calculations and technical aspects, will appear elsewhere.

Two photographs; 2 tables.

JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Precautions in Medical Radiology. Raymond R. Lanier. J. Arkansas M. Soc. **55:** 143–150, September 1958. (University of Colorado Medical Center, Denver, Colo.)

Practical considerations for dealing with the hazards of medical radiology are reviewed. There is at present a strong tendency to make the recommendations of *Handbook 60: X-Ray Protection* legally prerequisite in the several states to the use of x-rays and other radiations for medical purposes. Such legislation should exact registration of all sources of radiations and periodic inspection as to safety in usage.

The author surveys the activities directed toward protection in his own situation. [Until his untimely death in November 1958, Dr. Lanier was Professor of Radiology, University of Colorado Medical Center.] While radiological procedures are done when there is good clinical reason for them, unnecessary examinations, too frequent follow-up studies, fluoroscopy, especially in infants, and routine survey studies are avoided. Radiation therapy in benign conditions, including I^{131} therapy for hyperthyroidism as well as x-rays for warts, acne, etc., is used only as a last resort, almost never in young persons. Technical safety factors include high kilovoltage with the lowest mas possible, at the greatest practical distances, at least 2 mm. Al filtration over the tube port, the best screens and fastest film available consistent with the detail required, and limitation of field size by use of cones or diaphragms or light localizers. If the latter are unavail-

able, the patient's gonads should be shielded with protective material such as lead if they do not have to be in the field of examination. Well trained technicians such as those certified by the American Registry of X-Ray Technicians are essential. Technical personnel and physicians are not permitted in the room when the machine is operating unless the care of the patient demands their presence. All radium and radioactive materials are stored in adequately shielded containers according to the standards prescribed by the National Committee on Radiation Protection. Only properly qualified and experienced persons handle radioactive materials and then only with forceps or tongs, and with adequate shielding. Instruction from trained individuals on safe practices is sought. Inspections by trained health physicists or by qualified radiologists are made at least yearly, or whenever required.

One roentgenogram; 1 photograph; 7 tables.

Effects of Prednisolone in the Treatment of Superficial Radiation Lesions of the Skin and Mucosae. R. L'Abbé, E. Lebel, and G. Pinsonneault. J. Cana. A. Radiologists **9**: 49–54, September 1958. (Hôtel Dieu Hospital, Montreal, Que., Canada)

The authors report their experience in treating radiation lesions of the skin and mucosa with prednisolone preparations. For dry and moist epidermitis they use topical applications of prednisolone with neomycin ointment twice daily. In epidermitis with associated conjunctivitis and epithelitis at the eye level, Prednisolone Ophthalmic Ointment was applied three to four times daily. In buccal mucositis, prednisolone tablets were allowed to melt in the mouth three to five times daily. (Recommended dose: 1 mg. 5 times daily.)

In almost every case there was marked attenuation of symptoms and acceleration of the healing process.

The authors recommend this form of therapy to relieve subjective symptoms of radiation lesions, but not for the purpose of permitting higher radiation doses. The patient should be warned of a transient burning sensation on initial contact with the medication.

Sixteen photographs; 1 graph.

CAPT. NEIL E. CROW, M.C.
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EXPERIMENTAL STUDIES

Effects of Low-Dose X-Radiation on the Mouse Embryo. Ujihiro Murakami and Yoshiro Kameyama. J. Dis. Child. **96**: 272–277, September 1958. (Furo-Cho, Chikusa-Ku, Nagoya, Japan)

Whole-body roentgen radiation was administered to mice in a single dose of 25 or 50 r on the eighth day of pregnancy and the embryos were removed from the uterus on the thirteenth day of pregnancy. The factors were 200 kv, 20 ma, 80 cm., 0.5 mm. Al plus 0.5 mm. Cu filtration, 13.69 r per minute. Control and experimental animals were utilized, but the numbers are not stated.

There appeared to be no lethal effect upon the embryos. All observed abnormalities involved the central nervous system with the exception of a malformed jaw in 1 embryo. The basic disturbance was evident in the ependymal layer, usually manifest as a proliferation of the ependymal elements. Approximately one-fourth of the embryos receiving 50 r and one-eighth of those receiving 25 r seemed so damaged.

With these low levels of embryo irradiation no cases of complicated external deformity or other gross defects appeared. It was felt, however, that even though the central nervous system deviations tended to be microscopic, the damage was severe and prognosis in doubt. The possibility that some of the observed fetal damage was a result of maternal factors is considered but this is believed to be unlikely.

Seven photomicrographs; 3 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Acute Effects of Partial-Body Beta Irradiation of Mice. J. C. Crook, E. V. Hulse, J. H. Mulvey, and G. J. Neary. Brit. J. Radiol. **31**: 477–485, September 1958. (MRC Radiobiological Research Unit, Harwell, Didcot, Berks., England)

A study of the LD-50 relationship of dose *versus* the area of beta irradiation in mice was attempted. The radiation source was strontium 90, in the form of a carbonate salt sealed between layers of silver foil. The primary damage to the animals was due to a daughter product, yttrium 90, with a maximum beta-ray energy of 2.27 Mev.

During radiation to one-, two-, or three-fifths of their bodies, the mice were held in a celluloid tube inserted in a second cylinder which held the beta source. Surface doses ranged from 3,000 to 24,000 rads to hairless and CBA strains of mice.

As well as the expected skin burns, lesions of the intestine also occurred. The burns appeared on the fifth or sixth day for the hairless mice and healed by the twenty-eighth day. Skin lesions on CBA mice began on the twelfth or fourteenth day and healed by the twenty-eighth day.

No good LD-50 values could be obtained because of the mortality from intestinal ulcerations, which appeared within the fifth to tenth day for both groups.

Five figures; 10 tables.

GEORGE EDWARD COADE, M.D.
Indiana University Medical Center

Effect of Total-Body X Radiation from Near-Threshold to Tissue-Lethal Doses on Small-Bowel Epithelium of the Rat. I. Changes in Morphology and Rate of Cell Division in Relation to Time and Dose. R. Bland Williams, Jr., Jane Nicolet Toal, Julius White, and Harry M. Carpenter. J. Nat. Cancer Inst. **21**: 17–61, July 1958. (Naval Medical Research Institute, Bethesda, Md.)

In a detailed study the authors have correlated changes in cell division with changes in nucleic acid metabolism in the small bowel epithelium of the rat following total x-irradiation. This paper reports quantitative measurements of the changes in mitotic activity at various intervals after single doses varying from near-threshold to tissue-lethal.

Differential effects of x-radiation upon stem cells in interphase, in the crypts of the small bowel epithelium of adult, male rats, were demonstrated, consisting in an initial drop in mitotic activity, acute cell destruction, abortive mitotic recovery, prolongation of interphase, and final recovery. Acute destruction and an abortive mitotic recovery are responses of cells presumed to be in late interphase at the time of irradiation.

Final recovery appeared to involve a decrease in the intermitotic time of surviving stem cells. This provides a mechanism for replacement of those stem cells

that have been acutely destroyed, an explanation for the sustained "overshoot" in mitotic activity observed during recovery, and a restoration of the normal age relationship of epithelial cells lining the crypts and villi.

A tissue-lethal dose of radiation does not result in the acute destruction of the majority of cells involved in the continual replacement of the small bowel epithelium. However, a permanent inhibition of division occurs.

These effects of x-radiation on stem cells in the crypts of the small bowel epithelium are direct in the sense that they are not influenced by actions of irradiation upon the rest of the body. At the intracellular level, however, the effects are indirect in that they may be altered by environmental changes such as anoxia.

Twenty-four photomicrographs; 10 graphs and charts; 5 tables. JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Effect of Total-Body X Radiation from Near-Threshold to Tissue-Lethal Doses on Small-Bowel Epithelium of the Rat. II. Changes in Nucleic Acid and Protein Synthesis in Relation to Cell Division. Jane Nicolet Toal, James C. Reid, R. Bland Williams, Jr., and Julius White. J. Nat. Cancer Inst. **21**: 63–76, July 1958. (Naval Medical Research Institute, Bethesda, Md.)

Paper I of this series, abstracted above, presented the results of changes in morphology and mitotic activity produced in the small bowel of the rat by x-irradiation. This paper is a report of nucleic acid and protein synthesis in the same tissue under identical experimental conditions but with glycine-N^{15} as a tracer. The index the authors employed to follow the synthesis of DNA, RNA, and protein is the concentration of isotopic nitrogen found five hours after a single tracer dose of glycine N-15.

Sprague-Dawley rats were exposed to whole-body radiation in a dosage range of 225 r to 2,000 r. Five hours before sacrifice, each animal received intraperitoneally a tracer dose of glycine N-15.

It is becoming generally accepted that the DNA needed for cell division is synthesized somewhat before mitosis begins. The events observed by the authors in rat intestine after moderate doses of x-radiation demonstrate two clear-cut effects. One is a blockage that occurs almost immediately and prevents the stem cells in the crypts from entering mitosis even though they continue to synthesize DNA. The second effect is a block that becomes evident a few hours after irradiation and prevents stem cells in interphase from synthesizing DNA as well as from entering mitosis.

Three charts; 2 tables. JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Effect of Fractionation of Beta Irradiation on Rat Skin. Elly M. Jacobsen, A. K. Davis, and Edward L. Alpen. Radiation Res. **9**: 358–368, September 1958. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

Various reports have characterized the gross effects resulting from both single and periodic external exposure to β-radiation in laboratory animals and man. The present paper reports one of a series of investigations designed to impart information in respect to dose-effect relationships of skin subjected to β-radiation and the gross pathology of skin response to such treatment.

Female rats were exposed to a β-ray Sr^{90}-Y^{90} source at a skin dose rate of 14.6 rads/sec. Total doses of 6,000 or 12,000 rads were given in fractions of 200 to 1,000 rads at twenty-four or forty-eight-hour intervals. Daily observations were made during the development of the lesion and subsequently on working days until healing was complete.

At 200 rads every forty-eight hours epilation was the only observable response, even at a total dose of 12,000 rads. This total dose fractionated at 400 rads per forty-eight hours still failed to cause wet desquamation.

Daily exposures of 400 rads to a 6,000-rad total produced only dry desquamation. The threshold for wet desquamation lies below 600 rads daily to a 6,000-rad total, a dose which produces 50 per cent wet lesions. If the total dose was increased to 12,000 rads at 600 rads/day, all the rats had wet lesions. A dose rate of 1,000 rads/day shortened the mean time before appearance of wet lesions at a 6,000-rad total dose by two days, but 1,000 rads per forty-eight hours reduced to 50 per cent the number of rats having wet lesions. When the total dose at 1000-rad per fraction was increased to 12,000 rads, however, spacing no longer had any appreciable effect. Moreover, the injury induced appeared to have reached a maximum, and was similar to that observed in the animals receiving a total dose of 12,000 rads, 600 rads daily.

Six figures; 3 tables.

Effects of a Single Lethal Dose of Total-Body Co^{60} Gamma Irradiation on Calves. George Rosenfeld. Radiation Res. **9**: 346–357, September 1958. (National Naval Medical Center, Bethesda, Md.)

The author presents clinical, body-weight, temperature, mortality, hematology, and pathology data on the response of the calf (*Bos taurus*) to a single lethal dose of 600 r of total-body γ-irradiation from Co^{60} in a 4π exposure field. The dose, measured in air at the point subsequently occupied by the midline of the animal's body mass, represents the LD 40/9 or the LD 100/14 for male calves from three to five months old. The mean survival time for 23 animals maintained until spontaneous death was 9.9 days.

The clinical syndrome was characterized by progressive weight loss, recovery from an early diarrhea and anorexia, an essentially asymptomatic period of four to five days, the reappearance of watery diarrhea and anorexia, followed by inflammation of the eyelids, lacrimation, a viscid nasal discharge, lassitude, and unsteady gait. Pronounced malaise, apathy, and respiratory distress with marked salivation were usually apparent for twenty-four hours before exitus. The rectal temperature rise by the fourth day was usually prognostic of an early or delayed fatal outcome.

The early changes in the peripheral blood after exposure were spectacular. Within twelve hours the lymphocyte and eosinophil counts fell to near-minimum levels, whereas the heterophils increased about 800 per cent. The latter then dropped precipitously to their pre-irradiation level by the second day and thereafter decreased consistently until the seventh day, when few were detectable. The platelet count remained within the control range for the first five days, after which it decreased linearly. Lowered hematocrit values were observed usually by the ninth day.

The clinical and hematologic findings were readily correlated with the gross and histopathology data, which revealed the characteristic tissue changes already reported for other animals, namely, cellular destruction,

manifested particularly by the radiosensitive lymphoid and hematopoietic organs and gastrointestinal mucosae. Terminally, petechiae and hemorrhagic streaks were apparent throughout the viscera and parietes, and areas of hemorrhagic consolidation in the lungs. Evidence of infection, particularly pneumonitis, was the other outstanding agonal finding. After the seventh day, the hematopoietic syndrome predominated, and the pathological findings were mainly the sequelae of the severe pancytopenia resulting from bone marrow aplasia.

[The effect of a lethal dose of whole-body gamma-radiation on the adrenocortical function of the calf is the subject of another report by the same author (Am. J. Physiol. **192**: 232, 1958. Abst. in Radiology **72**: 476, 1959).]

Four figures; 2 tables.

The Relative Biological Effectiveness of Fast Neutrons and X-Rays for Life Shortening in Mice. H. J. Curtis and Katharine Gebhard. Radiation Res. **9**: 278–284, August 1958. (Biology Department, Brookhaven National Laboratory, Upton, N. Y.)

The relative biological effectiveness (RBE) of fast neutrons *versus* x-rays was measured for the shortening of the life span in mice. Three experiments were performed comparing these two radiations, and in each the ratio of x-rays to neutrons was such as to produce the same thirty-day mortality. The first experiment employed large single doses of the radiations (neutrons, 280 or 330 rads; x-rays, 475, 560, or 641 rads); the second, four smaller doses at seven-day intervals (neutrons, 512 rads; x-rays, 892 rads); and the third, four smaller doses at fourteen-day intervals (neutrons, 732 rads; x-rays, 1,272 rads). All animals were kept until natural death. The RBE was found to be the same (1.7) for acute lethal effects as for shortening of life span in all three experiments. The animals receiving neutron treatments, however, did not gain weight as fast as those treated with x-rays. In view of the previously reported high values of RBE for chronic neutron *versus* x-irradiation, the authors conclude that the relative recovery rates for neutrons *versus* x-rays are different for small and large doses.

Six graphs; 1 table.

The Relative Biological Effectiveness of 4-Mev and 200-Kvp X-Rays, Determined by the LD_{50} of the 4-Day-Old Chick Embryo. Robert F. Kallman, Roderic E. Steele, Mitchel Weissbluth, and Malcolm A. Bagshaw. Radiation Res. **9**: 270–277, August 1958. (Stanford University School of Medicine, San Francisco 15, Calif.)

The relative biological effectiveness (RBE or η) of supervoltage radiations has been determined by the method of Boland (Brit. J. Radiol. **27**: 680, 1954) in three different institutions. This method, based on the LD 50 of the four-day-old chick embryo, is quite rapid and shows a high degree of sensitivity, accuracy, and reproducibility. The present investigation was designed to determine this factor for 4-Mev x-rays relative to 200-kv x-rays.

Five almost identical experiments were carried out with a total of 372 hen eggs. Each experiment contained a 4-Mev series and a 200-kvp series of dose groups; the two series were irradiated simultaneously. The RBE (η) of 4-Mev x-rays compared with 200-kvp x-rays was obtained from the dose-survival curve for the 4-day-old chick embryo. Survival was judged by the number of embryos showing heart beat seven hours after irradiation. Ionization measurements at 200 kvp were converted to rads by means of the factor specified by the International Commission on Radiological Units and Measurements. Ionization measurements at 4 Mev were converted to rads by means of factors supplied by the ferrous sulfate dosimeter. The value of η (absorbed dose) was 0.90 ± 0.03.

Two figures; 1 table.

The Relative Effectiveness of Neutrons of 1.4-Mev and 14-Mev Energies and Gamma Rays in the Reduction of Fertility in the Male Mouse. J. F. Spalding, S. B. Hawkins, and V. G. Strang. Radiation Res. **9**: 369–377, September 1958. (Los Alamos Scientific Laboratory, Los Alamos, N. Mex.)

It is generally agreed that near-lethal doses of x- and γ-rays are required to produce temporary complete sterility in male mice and that permanent complete sterility cannot be produced at sublethal doses. In general, the female is more radiosensitive with respect to fertility than is the male. Nealy *et al.* (Nature **171**: 256, 1953), however, observed that this was not the case with fast neutrons. They reported that an accumulated neutron dose of 100 rep (93 rads) produced complete and permanent sterility in male mice, whereas an accumulated dose of 140 rep (130 rads) produced no demonstrable effect on fertility in female mice.

The authors' investigation was carried out to compare the relative effectiveness of 14-Mev fast neutrons, fission neutrons, and Co^{60} γ-rays in reducing fertility of CF-1 male mice.

One hundred and fifty male CF-1 mice were exposed to low weekly doses of Co^{60} γ-rays, 14-Mev neutrons, and fission neutrons over a ten-week period. A complete record of the data from litters was maintained daily for thirty weeks to determine the efficiency of the two neutron energies relative to γ-rays in reducing fertility.

The sex ratio of mice born to the animals in this study was 0.9 to 1.1 (males/females) and did not differ from that of the controls, regardless of the type or dose of radiation received.

Fission neutrons were found to be about 6.5 times as effective in reducing fertility in the male mouse as γ-rays, and 14-Mev neutrons were approximately equal to γ-rays in their effects.

Complete sterility was observed in the high-dose fission neutron group but, with the exception of one animal, complete recovery was observed when the experiment was terminated.

Six illustrations; 1 table.

An Increase in Tolerance in Mice by Field-Fractionated (Sieve) X-Irradiation. Masatoshi Sakka and Rikisaburo Kamata. Radiation Res. **9**: 341–345, September 1958. (Tokyo Medical and Dental University, Yushima, Bunkioku, Tokyo, Japan)

An increase in survival of mice and rats exposed to whole-body sieve irradiation as compared with animals receiving whole-body irradiation without a sieve has been reported (Japan J. Cancer Clinic **1**: 418, 1955). The present investigation was designed to determine the LD 50/28 in whole-body irradiation with and without a sieve, and to find out whether the increase in survival with the sieve is due to a rapid recovery from the radiation damage.

Male albino mice ranging from 18 to 25 gm. in weight were employed as test animals. The sieve used was a lead plate 3 mm. in thickness, with round holes 0.8 cm. in diameter, 1 cm. apart. The ratio of the open to the closed area was 1:1.

In the first experiment various amounts of radiation were delivered in single doses. The LD 50/28 with radiation without the sieve (conventional radiation) was 400 to 500 r in air, while with the sieve it was 1,200 to 1,600 r, *i.e.*, mice irradiated with the sieve tolerated three times as large an air dose as conventionally treated animals.

Other experiments were carried out with fractionated irradiation by conventional methods, by the sieve technic, and by the two combined. Results of these experiments indicated that the increase in tolerance is not due to the difference in recovery rate. The distribution of death with the two forms of irradiation suggests a possible difference in mode of death.

Endotoxin Treatment and X Irradiation in Mice Bearing Transplanted Tumors. Joanne W. Hollcroft and Willie W. Smith. J. Nat. Cancer Inst. **21:** 311–329, August 1958. (Radiation Branch, National Cancer Institute, Bethesda, Md.)

A series of experiments was undertaken with a relatively large number of mice to determine the tumor inhibiting or sensitizing effect of endotoxin derived from *Salmonella typhosa* and roentgen irradiation alone or together. The data derived from the multiple experiments are succinctly reported in tables and graphs. In each instance a suitable number of control animals was utilized and comparisons were made. Effects of localized and total-body roentgen irradiation following administration of endotoxin were observed in animals transplanted with lymphosarcoma and with reticulum-cell sarcoma. Effects of the treatments were judged by survival as well as by body weight and organ weight of tumor-involved tissues.

Salmonella typhosa endotoxin was found to have a small inhibitory effect on the local growth of lymphosarcoma. Whole-body roentgen irradiation with 475 r, or 1000 r irradiation to the tumor alone, produced about the same degree of tumor regression. In both cases when endotoxin had been given twenty-four hours before irradiation an additive effect on tumor regression was seen.

When mice bearing a disseminated reticulum-cell sarcoma received whole-body roentgen irradiation their survival time was increased, but increasing the radiation from 600 r to 1500 r did not produce a steadily increased survival time. Fractional irradiation doses repeated at intervals of two weeks or more resulted in more effective survival time than single exposures. Endotoxin given twenty-four hours before irradiation increased tolerance to radiation. Pre-treatment with endotoxin also produced an increase in survival time of irradiated tumor-bearing mice which was greater than the sum of the increase which could be attributed to endotoxin or radiation alone.

There is evidence that *Salmonella* endotoxin effects its increased tolerance to radiation by stimulating an early recovery of hematopoiesis. The possibility of a synergistic action between the endotoxin and the irradiation on tumor effect is mentioned but unproved.

Six photomicrographs; 2 photographs; 4 graphs; 6 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Effect of Chemical Protection and Bone Marrow Treatment on Radiation Injury in Mice. Paul Urso, C. C. Congdon, D. G. Doherty, and Raymond Shapira. Blood **13:** 665–676, July 1958. (Oak Ridge National Laboratory, Oak Ridge, Tenn.)

Early death resulting from lethal radiation is attributed in large part to the injury suffered by the hematopoietic tissues. To study the manner in which MEG (2-Mercaptoethylguanidine-HBr) is capable of reducing the effects of irradiation, the effect of the compound on the response of the hematopoietic system to lethal and sublethal irradiation was studied in mice. The following are the authors' conclusions:

"MEG significantly modified the response of the bone marrow, peripheral blood, leukocytes, spleen, thymus, body weight, hematocrit, and histology of the hematopoietic organs to lethal (900 r) and sublethal (450 r) x-irradiation in CAF_1 mice.

"MEG reduced the effect of 900 r on the bone marrow, granulocytes of the blood, hematocrit, spleen, thymus and body weight by a fraction of approximately two.

"Combined treatment (MEG and isologous bone marrow) of mice exposed to 900 r demonstrated that MEG is primarily responsible for preventing the early destruction of bone marrow, but bone marrow injection was primarily responsible for causing a more rapid recovery of the bone marrow.

"In mice receiving combined treatment, recovery of the leukocytes and spleen was primarily influenced by the bone marrow injection; whereas recovery of the thymus and body weight was primarily influenced by MEG. The hematocrit values were normal after combined treatment."

Ten graphs.

JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Effects of Donor and Host Lymphoid and Myeloid Tissue Injections in Lethally X-irradiated Mice Treated with Rat Bone Marrow. George W. Santos and Leonard J. Cole. J. Nat. Cancer Inst. **21:** 279–293, August 1958. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

The effect of injections of isologous mouse or rat spleen, thymus, and bone marrow on the response of lethally x-irradiated LAF_1 mice treated with rat bone marrow was investigated. The experimental animals were given 870 r total-body irradiation. This represents 100 r more than the LD 99 dose for this strain of mice.

The injection of isologous mouse spleen or thymus homogenate on the day of irradiation or twelve days after lethal irradiation with 870 r resulted in the rapid rejection of the rat bone-marrow graft and death due to bone-marrow failure. No adverse effect upon the survival time of irradiated mice and persistence of the rat bone-marrow graft was noted when isologous liver homogenate, lysed isologous liver, lysed isologous spleen, and lysed isologous thymus were injected. The injection of isologous mouse bone marrow on the day of irradiation or three days after irradiation resulted in the rejection of the rat bone-marrow graft and survival times as long as those seen in irradiated mice treated with isologous bone marrow alone. The survival times of lethally x-irradiated mice treated with bone marrow were significantly shortened when rat spleen or thymus was injected with the rat bone marrow. The rat bone-marrow graft in these mice continued to proliferate until their death. Death resulted, presumably, from an im-

munological response of the injected rat cells. No adverse effect either on the graft or on survival time of the host was noted when lysed or lyophilized rat tissue is given with rat bone marrow.

The significance of these findings in elucidating some of the immunological principles involved in foreign bone-marrow transplanation is discussed. "If the early regeneration or remaining amount of host immunogenic tissue is negligible, as we might expect from relatively high radiation doses, the degree of immunogenic potential in the injected bone marrow will determine *not* whether the *graft survives* but rather how long the *host will survive*. Paradoxically, though it appears undesirable to have an excess of immunogenic cells in the foreign bone-marrow graft, the possibility exists that a small amount of immunologically active tissue may be necessary for *long surviving* grafts to suppress any immunogenic tissue of the host that may be beginning to regenerate." JAMES W. BARBER, M.D.
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Alteration of Beta-Radiation Lesions of the Skin by Cysteine, Nitrite, Hypoxia, Spleen Homogenate, and Bone Marrow Homogenate. A. K. Davis, D. Cranmore, and E. L. Alpen. Radiation Res. **9:** 222–228, August 1958. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

The purpose of the investigation described in this paper was to evaluate some of the more common agents which are known to reduce the lethal effects of whole-body ionizing radiation in terms of their specific action on radiation damage to skin. Hypoxia, cysteine, and nitrite were studied as representative of the most effective preprotectants, and spleen and bone-marrow homogenates as representative of the most effective post-protectants for whole-body radiation effects. The radiation source employed was a Van de Graaff accelerator producing 1.5-Mev electrons at 1.8μa of beam current which was equivalent to a dose rate to skin of 80.5 rads/sec. Female Sprague-Dawley rats were used in the experiments.

The most effective agents were found to be the preprotectants cysteine (1.0 mg./gm. body weight) and hypoxia (95 per cent N, 5 per cent O_2), which prevented the development of wet desquamation in all the rats exposed to an ulcerating dose of radiation. Nitrite (0.075 mg./gm. body weight) prevented ulceration in 64 per cent of the treated animals.

Unheated spleen homogenate (0.5 gm. spleen per rat) prevented skin ulceration in only 16 per cent of the irradiated rats. Spleen homogenate previously heated to 80° C. for ten minutes protected as many rats as did the nonheated material. Consequently, the protection achieved with the spleen homogenate is believed to represent a nonspecific response to the injection of the substance. Bone marrow homogenate (150 mg. per rat) did not affect the course of injury.

Lymphatic Tissue Changes in Lethally Irradiated Mice Given Spleen Cells Intravenously. C. C. Congdon, T. Makinodan, M. Gengozian, I. C. Shekarchi, and I. S. Urso. J. Nat. Cancer Inst. **21:** 193–211, July 1958. (Oak Ridge National Laboratory, Oak Ridge, Tenn.)

Isologous spleen, like bone marrow, injected into lethally irradiated mice has been shown to cause recovery from the acute radiation syndrome, whereas homologous spleen treatment increases the lethality of total-body x-radiation. The present investigation concerns the lymphatic tissue changes in irradiated mice following spleen injections. A group of mice which had received intravenous injections of isologous spleen cells were irradiated with 950 r, following which autopsies were performed at varying intervals. A second group of mice received 950 r after intravenous administration of rat spleen cells, guinea-pig spleen cells, and thymus cells from newborn mice.

The treatment of x-irradiated mice with isologous spleen caused more rapid regeneration of splenic white pulp and of lymph nodes than did treatment with isologous bone marrow. Homologous spleen injections in lethally irradiated mice caused violent reactive changes in lymph nodes and spleen, and parenchymatous degeneration in several organs. In both groups of animals irradiation was followed by an accumulation of "large lymphocytic cells" in special locations on the spleen. Homologous bone marrow injection eventually produced reactive changes in spleen and lymph nodes similar to those with homologous spleen, but without prior accumulation of large lymphocytic cells.

Seven photomicrographs.

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Effect of X-Rays on Fe^{59}-Labeled Granulocytes and Lymphocytes of the Rabbit. Luigi Resegotti. Radiation Res. **9:** 240–247, August 1958. (Istituto di Patologia Medica, Università di Torino, Turin, Italy)

The effect of 200-r whole-body x-irradiation on the incorporation of Fe^{59}-labeled plasma iron into the hemin of leukocytes of the rabbit was investigated.

The specific activity of granulocyte hemin iron decreased under the effect of x-ray exposure, but the number of granulocytes remained unaltered. This result indicates an inhibition of myelopoiesis by irradiation. The number of lymphocytes in the circulation decreased following irradiation, whereas the specific activity of their hemin iron remained constant. This observation suggests that old nonlabeled and new labeled lymphocytes are affected to the same extent by irradiation. During the first day, however, the specific activity of lymphocyte hemin iron is higher in the exposed animals than in the controls, which masks the effect of irradiation on lymphocyte hemin formation.

Five graphs; 1 table.